This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

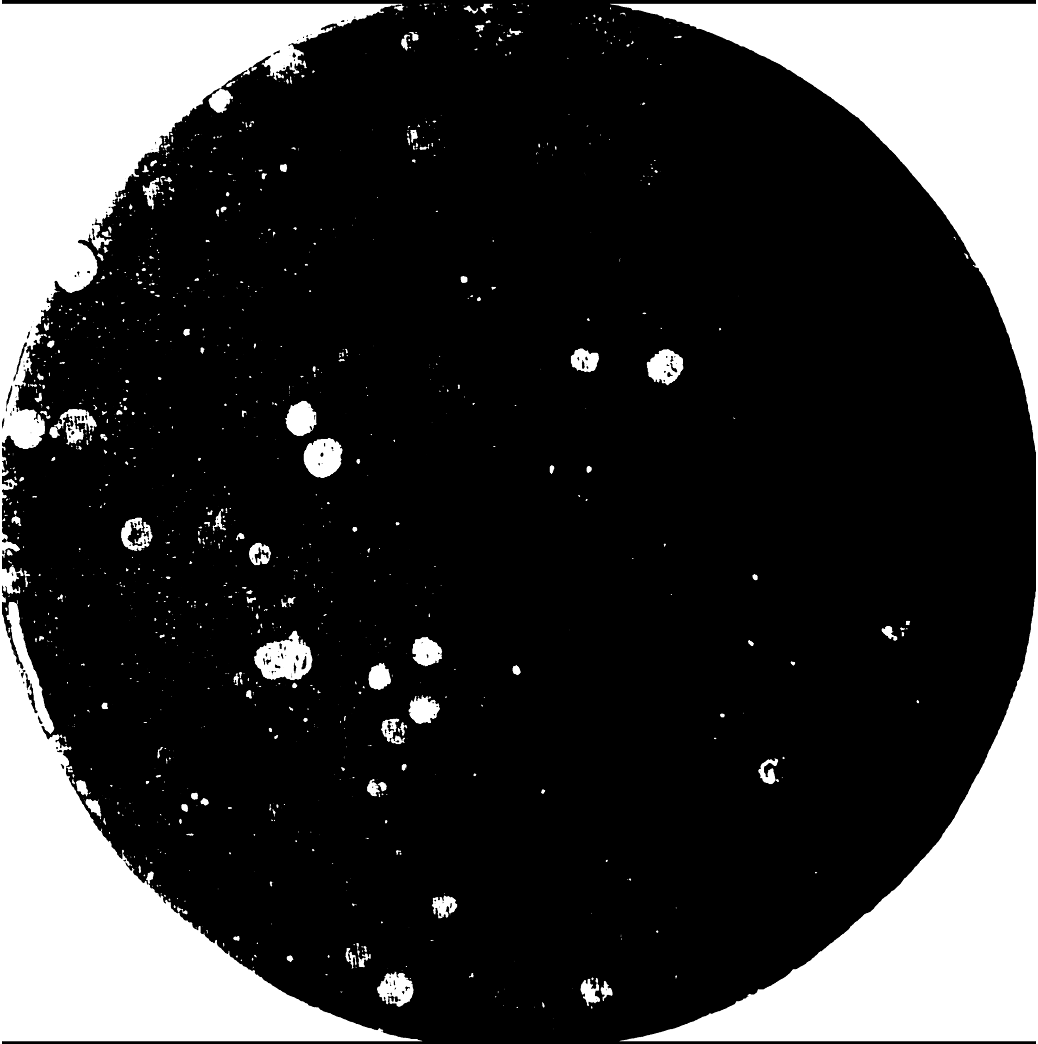
+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`



Report

Arkansas Agricultural Experiment Station

Agric. Dept

LIBRARY
OF THE
UNIVERSITY OF CALIFORNIA.
GIFT OF
Arkansas Agric. expt. station

Received July, 1900.

Accession No. 80,021. Class No. AGRIC. LIBRARY.

AGRICULTURAL
LIBRARY,
UNIVERSITY
OF
CALIFORNIA.

H

20750

Arkansas

Agricultural Experiment Station

EIGHTH ANNUAL REPORT

For the Year 1895.

Fayetteville, Ark.

Agricultural Experiment Station

FAYETTEVILLE, ARKANSAS.

EIGHTH ANNUAL REPORT

FOR THE YEAR 1895.

NOVEMBER, 1895.

"DIPLOMA PRESS,"
ARKANSAS DEMOCRAT CO., LITTLE ROCK.
1895.

S37
E5
v. 8-12
AGRIC.
LIBRARY

80021

ARKANSAS EXPERIMENT STATION,
FAYETTEVILLE, ARK., November 16, 1895.

To His Excellency, JAMES P. CLARKE,

Governor of Arkansas:

SIR—

I have the honor to transmit to you herewith the Eighth Annual Report of the Arkansas Agricultural Experiment Station.

Most respectfully, your obedient servant,

R. L. BENNETT,
Director.

CONTENTS.

Page.

LETTER OF TRANSMITTAL 2

BOARD OF TRUSTEES 4

STATION STAFF 4

FINANCIAL REPORT 5

REPORT OF DIRECTOR 6

REPORT OF AGRICULTURIST 2, 159

REPORT OF ASSISTANT AGRICULTURIST 33, 99

REPORT OF HORTICULTURIST 55

REPORT OF VETERINARIAN 129

REPORT OF CHEMIST 181

GENERAL INDEX 187

Agricultural Experiment Station.

BOARD OF TRUSTEES.

His Excellency, J. P. CLARKE, *President*.

HON. W. H. LANGFORD.
HON. C. C. HAMBY.
HON. B. C. BLACK.
HON. W. N. YATES.
HON. J. B. McDONOUGH.
HON. JAS. T. HENDERSON.

BOARD OF CONTROL.

HON. J. T. HENDERSON. HON. W. H. LANGFORD. HON. C. C. HAMBY.
THE PRESIDENT OF THE UNIVERSITY. THE DIRECTOR OF THE STATION.

STATION STAFF.

R. L. BENNETT	DIRECTOR and Agriculturist.
GEO. L. TELLER	Chemist.
R. R. DINWIDDIE	Veterinarian.
J. T. STINSON	Horticulturist.
C. L. NEWMAN	Assistant Agriculturist at Camden.
GEO. B. IRBY	Assistant Agriculturist at Newport.
J. F. MOORE	Assistant Chemist and Librarian.

FINANCIAL REPORT

AGRICULTURAL EXPERIMENT STATION,

In Account with the United States Appropriation.

1895. **DEBTOR.**

To Receipts from the Treasurer of the United States as per Appropriation for the year ending June 30, 1895	$15,000	00
To sales produce	468	31
	$15,468	31

CREDIT.

By Salaries	$ 9,013	25
Labor	1,276	71
Publications	1,968	45
Postage and Stationery	161	95
Freight and Express	216	15
Heat, Light and Water	171	95
Chemical Supplies	194	80
Seeds, Plants and sundry supplies	250	21
Fertilizers	92	10
Feeding Stuffs	71	30
Library	233	65
Tools, Implements and Machinery	124	38
Furniture and Fixtures	75	50
Scientific Apparatus	15	95
Live Stock	15	00
Traveling Expenses	537	99
Contingent Expenses	519	50
Building and Repairs	529	47
	$15,468	31

The foregoing Statement is copied from the Experiment Station books which have been duly examined and found correct by the Auditing Committee of the Board of Trustees.

R. L. Bennett,
Director.

REPORT OF DIRECTOR.

This report contains the completed work and financial statement of the fiscal year, ending June 30, 1895.

The completed work of the year is contained in seven Bulletins, and a full text of each appears in the succeeding pages.

The Bulletins and their subject matter are as follows:

Bulletin 31—Agriculture—Fattening Mature Steers on Cotton Seed and Cowpea Hay—Cowpeas—Sweet Potatoes —Peanuts — Cotton Varieties — Minor Miscellaneous Subjects.

Bulletin 32—Farm Drainage—Protection of Soil from Surface Washing—Hillside Ditches—Terraces—Drainage of Wet Lands—Indications of the Need of Drainage— Open Ditches—Underdrains.

Bulletin 33—Insects—Insects Injurious to Fruits and Vegetables and Remedies for Destroying Them.

Bulletin 34—Vegetable Gardening—Vegetables—Varieties, Culture and Fertilization—Sundry Experiments.

Bulletin 35—Animal Pathology—Verminous Bronchitis— Parturient Apoplexy of Cows—Hog Cholera and Other Swine Diseases—Tuberculosis of Cattle—Glanders in Horses and Mules.

Bulletin 36—Grasses and Clovers—Suited to Different Soils for Pasture and Meadow.

Bulletin 37—Syrup and Molasses—Sugar Contents of Various Brands of Molasses—Home Made Syrup.

The past year has been the most prosperous one in the Station's history, both in the amount of work done and the increase of public interest in the Station Work. While requests for information and for Bulletins have been made each year, and have been constantly increasing, more requests have been received this year than in previous years. A detailed report of Station affairs is not made here as that report is made to you and to the trustees at your regular Annual Meeting.

R. L. BENNETT,
Director.

Fattening Mature Steers on Cotton Seed and Cowpea Hay.

Object of the Experiment. (1) To determine the value of cotton seed and cowpea hay for fattening steers. (2) To show the approximate profit in fattening mature steers for market on cheap foods.

The production of beef cattle and feeding cattle for beef offers good profits to farmers of the State. The large areas of natural pasturage and the mild climate of the State enable cattle to be raised cheaply. It is largely the practice at the present time by those who raise cattle to sell them when large enough for beef to feeders who ship them elsewhere and fatten them for market. Good food can be as cheaply grown in the State as anywhere, and there is no reason why cattle should not be fattened for market in the State and by the grower, instead of selling them just at the time when they would return him a good profit in a short time. When rough cattle are fattened the gain in flesh may not do more than pay for the feed and care in fattening, but the increased value of the animal's original weight by feeding constitutes the main source of profit to the feeder. There is as ready market for beef as there is for cotton, and when the local demands for beef are unequal to the supply, shipments can be made to St. Louis, Chicago or Kansas City, where sale can be found for cattle at all times and the supply of fat cattle never exceeds the demand. If a farmer was unable to fatten a car load for shipment he could arrange with a neighbor to ship together and thus make up a carload. To secure the greatest profit from feeding cattle, intelligence and economy must be exercised. The Station recently issued a bulletin to furnish information on economic feeding. The bulletin gives in detail the rational principles of economic feeding, and the value of Arkansas stock foods. Cattle feeding furnishes a market for unsalable food products by converting them into salable beef, and it keeps on the farm in the manure the fertilizing constituents of the foods.

Probably the two cheapest and best cattle foods in the State are cotton seed and cowpea hay. Cotton seed has declined in price this year to as low a figure as cotton, and pea hay as well as other hay when home markets are supplied cannot always be profitably disposed of, but by feeding the two foods to mature animals, and converting them into beef, good profits can be realized. The cowpea has another value besides its important one as a hay plant on worn soils and that is its capacity to largely improve a soil by its stubble and roots that remain after the vines are cut for hay. There is no other hay-plant that can be so easily grown and that will produce so much good hay on the worn cotton soils as the cowpea. With these two important foods a trial was made this year of feeding them to steers for beef. They were fed to two steers in an experiment that was made, among others, four years ago, but the object was a different one and the ration of seed fed was insufficient for this experiment, hence the result would not answer the purpose of this experiment. Cotton seed meal is a better food than cotton seed and would have been used, and farmers would be advised to use it instead of seed for feeding and for fertilizing, but the rate of exchange at the cotton oil mills is too much against seed.

If cotton seed could be taken to the mills and exchanged for the same quantity of meal and hulls as the seed contained and an additional quantity of meal to justify hauling and to pay for the oil, it would be advisable to do so, both for feeding and fertilizing. The hulls would be of little value as a manure, but could be used for mulching, bedding or feeding. No trials of other foods were made because none are so cheap as these and combine as many advantages.

Two half-grade 3-year-old steers were selected for the trial. They were not extra good steers but a little above the average range steer, and were in a thrifty condition but not fat. Feeding was begun January 23 in roomy box stalls, where the steers remained during the feeding period of ninety days. During the last ten days of the feeding period the steers made little daily gain. Three to four months is about the usual length of time that mature range steers are fed for market. Water and salt were kept constantly before them. The foods were accurately weighed twice daily to each animal, and as much given them as they would eat. Their appetites governed the amount of food fed at each feeding. When any hay or seed was left uneaten that amount was deducted from the total amount fed. The food was never refused except, occasionally, a little of the coarse part of the hay was left uneaten. From January 23 to February 8 a ration of 1 pound of seed to 2 pounds of hay was given, but as that proportion was not well balanced and the steers showed a desire for more seed the quantity of seed was increased. A ration was calculated to as near a balanced one as was possible with the two foods and for a thousand-pound steer a proportion of 13 6-10 pounds seed and 20 pounds hay was fed. That proportion was continued until the end of the feeding. The animals showed a desire for more seed and possibly they might have gained more if more seed had been given them, but it was feared that a larger quantity would derange their bowels. The steers took to the seed at once, though it had never been fed them before, and during the entire period their bowels were never deranged. In the table given below can be seen the daily average amounts of seed and hay fed. The subjoined table gives the data of the experiment.

DATA OF FEEDING EXPERIMENT.

	Weight at Beginning.	Weight end 90 Days.	Gain.	Foods Fed.	Pounds Food Eaten in 90 Days.
Black Steer............	876	1,150	274	Cowpea hay.. Cotton seed....	1,484 972$\frac{31}{32}$
Red Steer............................	946	1,216	270	Cowpea hay.. Cotton seed....	1,553½ 1,047$\frac{9}{32}$

	Cost Foods.	Cost Steers, 2 Cents.	Cost Steers and Cost Feeding.	Value Steers in St. Louis, Mo., 3½c less ⅓c for freight, etc.	Profit.
Black Steer............................	$8.36	$17.52	$25.88	$36.41	$10.53
Red Steer............................	8.82	18.92	27.74	38.51	10.77

The following report was made on the cattle at the close of the feeding by a man well-known as having had long experience in feeding, shipping and butchering cattle, and is entirely reliable:

NEWPORT, ARK., May 10, 1894.

R. L. Bennett:

SIR—I examined the two steers in the feeding experiment as requested by you and herewith hand you my opinion of them. The steers will grade well fattened butcher steers and at this date will sell in St. Louis for 3½ cents per pound.

Shipping expense to St. Louis, yardage and shrinkage will be fully covered by one-third cent per pound. The steers were free of big bellies. The prevailing price in this section for such steers as these were before they were fed was 1½ cents per pound. W. B. CHASTAIN.

The rate of gain of the steers is a little above the average, but it is not more than the average rate of gain of steers when fed on good foods. Some steers might have gained less, while others might have gained more in the trial, but these gains can be accepted as being as near the average gain as those foods are capable of producing, and for general practice they are amply correct. When considering the gains the high feeding qualities of the two foods should be remembered.

The price paid for the steers was 2 cents, which is more than they would have sold for on the range. They were bought from a party who had bought them to feed. As stated in the above letter, the local price for steers of that class on the range is 1½ cents, and for lighter steers much less is paid. In calculating the profits in the above table 2 cents was used as cost price, so it will appear that if the real value of the animals had been used, the profit from feeding would have been larger. But the half cent or five dollars a head can go as a safe margin. The values of the foods are what they are selling for in Newport. The price for pea hay, $8 a ton, may be more elsewhere, but if sold at that price the profit would be good. When converted into beef the hay can be sold at that price, hence a good market can be made for it if none exists for it in its natural state. The price of cotton seed, $5 a ton, is what the mills are paying for it at Newport, and about the same price is paid for it elsewhere in the State except where convenient to haul to cotton oil mills and save freight. The labor of feeding is not considered in the above table, because one man can attend to seventy-five or more steers. The manure is not considered in the profit, but it has much value. Cotton seed has been objected to for feeding in large quantities to cattle because of the lint on the seed. But when it is remembered that the seed that an animal should properly have has much less lint than hulls when they are fed as the sole coarse food with meal, that objection appears groundless. The oil in the seed will sometimes scour cattle at first when large quantities are fed, and to avoid that the quantity of seed should be increased gradually during the first ten days to the desired quantity. If an animal scours, a change from seed to corn will restore the bowels in a few days, and then the seed can be resumed.

Two small 1½-year old steers were fed for 35 days in the experiment in exact manner of the two large steers. They showed no bad effects whatever from the seed, and made a daily average gain of 3.1 pounds.

REVIEW.

1. The trial shows that cotton seed and cowpea hay are excellent fattening foods.

2. That raw cotton seed can be fed to cattle in proper amounts with pea hay without bad effects. This statement is warranted by this and two other similar trials previously made by the station, and experience of farmers.

3. That there is good profit in fattening rough mature steers for market with those foods estimated at good market prices.

4. The experiment was undertaken to determine as nearly as possible the practical feeding value of cotton seed

and cowpea hay for fattening steers, and to show the approximate profit in fattening mature steers for market. The results appear to show that these ends are attained as near as possible for all practical purposes.

Experiments have been made at other stations with cotton seed fed raw, roasted and boiled, and the results showed that boiled and roasted seed were less laxative and perhaps made a little larger gain than raw seed, but that the expense of roasting and boiling was not justified by the extra gains. Roasted seed have been found to be much less digestible than raw seed.

Where farmers have rich soil, red clover and some of the cultivated perennial grasses would be better to grow for hay for feeding than cowpeas, and on rich partially wet land, or annually overflow lands, Johnson grass could be used to better advantage for hay than any plant, and where feeding is to be done on a large scale with a hundred or more steers, silage would be a profitable supplementary food.

VALUE OF THE MANURE FROM STEERS FED COTTON SEED AND COWPEA HAY.

The value of peavines and crushed cotton seed as manures is unquestioned, and it is often a question when those materials are to be used as a fertilizer whether it would not be more profitable to feed them first to stock and return the resulting manure to the soil. The practice is often advised as the most economical manner of using the materials. When they are fed to fatten mature steers they lose little of their fertilizing value, and in farm practice the loss will not be apparent, and for short growing crops the manure will be much more active. The loss is greater when the materials are fed to milch cows or growing animals. When feeding is done the liquid and solid manure must be carefully saved and all loss by leaching and other causes prevented. As to whether the practice of feeding before using as a manure would be more profitable will have to be determined by each individual farmer after considering the cost of cutting and curing the vines, cost of feeding and returning the manure, spreading it on the soil and the profit from feeding the animals. Cotton seed meal is a better manure than the same amount of meal applied in the form of cotton seed. Crushed cotton seed is a better manure than whole seed, and when oil mills are not convenient to get an equitable exchange of meal for seed, the seed should be crushed before using as a manure. Whole seed produces better results on clay than on sandy soils. If anyone concludes after considering the cost of feeding and the profit from it that it is not profitable to feed pea hay and cotton seed to cattle before using as a manure, then this suggestion is made: Grow pea vines and turn them under in the fall and they will supply all the nitrogen needed by the succeeding crop, so that the nitrogen of the cotton seed, its chief fertilizing element, is not needed. Then sell the seed and purchase in cheaper forms the potash and phosphoric acid contained in the seed and that was removed from the soil and apply them in proper quantities to the cowpeas at planting. They will cause an increased growth of pea vines and remain in the decaying vines for the use of succeeding market crops. The increased growth of vines will add to the soil an increased amount of nitrogen and humus forming material which are the two most necessary things in all Arkansas soils.

The foregoing feeding experiment is only applicable to the cotton growing section of the State. In northwest Arkansas where cotton is not grown, the seed cannot be had for feeding, but corn or other concentrated foods, if cheap enough, could be used to take the place of cotton seed, and clover and grass hay would probably take the place of cowpea hay, except on poor soils. If those foods could be grown sufficiently cheap, and there is little doubt that they could, rough cattle could be profitably finished off for market in that section.

Cowpeas.

Varieties. Many varieties of cowpeas were grown at the Station this year, but only the best ones will be reported. Several of the best varieties were grown on the Station before, and notes made on their growth. The cowpea has now become so well known that its value for table use, forage for cattle, and for green manuring do not require attention. The many varieties in cultivation are commonly distinguished by the color and shape of the seed, and the character of growth. Varieties differ much in the amount and character of growth, and earliness. These differences determine the best ones for hay and for manuring. The yield of seed by the best varieties was much the same, and as the yield is so affected by season, soil and time of planting, no estimate of yield was made. Neither was an estimate made of the yield of vines, because it was not difficult to select the best varieties for hay and manuring. Varieties of cowpeas can be divided into two general classes, according to whether the vines grow bunched, or run. But in such a division it must be remembered that the time of planting influences the character of growth. When planted early in spring the tendency is for the peas to grow more vines or run more than when planted late. The time of planting also affects the yield of peas. Late planting will, in most cases, be likely to make more peas than early planting. Planting was done May 10, 1894, and all varieties grew a large quantity of vines and made but few peas. The soil upon which they were planted was not very fertile.

Unknown Pea. A very rank grower; does not creep, but is inclined to run instead of bunch. The main vine grows upright at the root, and does not lie upon the ground. The dry seed, when new and fresh from the hulls, is greenish white in color, and has blue eyes, but as they increase in age and exposure to light they change in color to a light and to a dark brown. When planted in early spring they have never yielded many peas, but when planted later the yield has been good, and the vines grew more upright and bunched. This pea is the heaviest yielder of vines of any pea and retains its leaves well.

Clay Pea. This pea has a small vine and leaf, and is a creeper. The seed is small and of a dark yellowish color. It is said to be valuable for poor clay soils.

Black Pea. This is a well-known running variety. The seeds are large and black, and are said to stand rainy weather without rotting. Good yielder of peas and vines.

Red Ripper. Is a runner, and produces much vine. Seed red color with medium sized pods, that are long and well filled.

Conch Pea. Is a creeper of vigorous habits. Did not yield heavily of pods; seed white and oval.

Wonderful Pea. Is the Unknown pea under a new name. Seed of each were obtained from three different sources and planted, and the plants that grew from them were alike in every respect.

Whippoorwill. Is the pea most generally planted in this State. It is early, and strictly a bunch pea, but on rich soil, or when planted very early, it grows considerable vines. Its upright and bunch growth enables it to be cut and handled for hay with greater ease than any other variety. It yields well of peas and vines. Its seed is medium sized, and of brown color with dark spots.

General Conclusions. From two years' experiments with these varieties and several years' experience with them, the following statements can be made:

1. The Unknown pea is superior to all others in yield of vines, and is therefore the best pea for manuring, and is superior to any of the running varieties for hay. When planted late it does not run, yields well of pods, and is easily handled for hay. When planted on good soil in early spring it grows coarse and the vines run very much.

2. The Whippoorwill is the best early pea for hay when two good cuttings are desired, or when the first crop is cut for hay and the second turned under to enrich the soil. Whether planted early or late it always grows bunched and upright except when planted on fertile soil.

3. The creeping or long vined varieties are unsuited for hay or manuring. The vines are too difficult to handle for hay or to properly turn under.

4. Peas planted in early summer make more peas and grow more bunched than when planted earlier.

5. There are twenty-five or more varieties of cowpeas, but for hay and manuring, when properly handled, the Unknown and Whippoorwill have done the best. Many of the varieties possess little merit.

When the value of the cowpea for hay and manuring is considered, it is very strange that the plant is not grown more than it is for those two purposes by the farmers of the State. Most all soils of the State need improving. The almost continuous clean cotton and corn culture to which they have been subjected since they were first cleared has destroyed almost all vegetable matter in them, and no plant will restore them so cheaply and effectually as the cowpea. Nitrogenous vegetable matter must be made the foundation for the improvement of worn soils, and the cowpea is the best plant to supply it. Much hay is annually imported into the State that can be better supplied by the cowpea and at much less expense. The cowpea will yield more good hay on the poor soils of the State than any other plant, and as hay has always sold for good prices and the soil needs renovation, every farmer in the State should grow annually a certain area in cowpeas. By so doing hay would be cheaply made and the soil enriched at the same time. When the vines are cut for hay and only the stubble and roots are left, they will largely increase the yield of succeeding market crops. In view of the great value of the cowpea to the State for hay and manuring, and that inquiries are frequently received concerning it, I will state briefly a few practical points on their cultivation. The quantity of seed usually sown varies from one and a half to two bushels per acre. Seed can be planted at any time after the last frost until July 15, but in the mountains planting should not be later than July 1. All grain stubble should be sown in peas for either hay or manure. The seed can be plowed in broadcast with a cultivator on the turned stubble. Peas can be profitably planted in corn at the last plowing, and the yield of seed is usually good, and the vines and roots will improve the soil very much. Planting can be done either in rows or broadcast. When in rows, cutting with a scythe can be done better, and the vines do not tangle up so badly as when sown broadcast. For early spring planting it is doubtless better to sow in rows, and cultivate shallow once. One furrow to the row with a broad scrape or a five-tooth cultivator will be sufficient. A good cotton planter makes an excellent implement for sowing peas in rows on a smooth soil. The proper time to cut for hay is when about two-thirds of the pods have formed or when the first pods have changed color. More and better hay is then made, and it will cure easily. Cutting should not be delayed longer than that period, because in most cases the leaves will soon begin to fall, and will shatter off easily when the vines are handled. The Whippoorwill pea planted in early spring can be cut twice for hay. The cowpea is practically a sure crop for hay, being little affected by drought. If a plant is wanted for hay for one season only leguminous plants are best, and of them the cowpea is best on *worn* soils. Where peas are planted on a large scale a hand threshing machine can be profitably used to thresh out the seed. When cowpea hay is properly cut and cured it is unexcelled for all live stock. The proper time to turn under vines for manuring is in the fall. The vines should not be turned under green in the summer because fermentation is liable to set up and injure the vines and soil, and in summer the soils should not be turned deep nor opened up, as the vines would do. The vines can be safely turned under in early fall if the soil is moist and the weather cool. When the vines are left exposed on the surface to rains and freezes they lose a very large part of their nitrogen, which is their most valuable constituent. The soil when turned in the fall suffers some from bare exposure, but the loss is less than from pea vines left exposed all winter. The loss from the turned soil can be easily prevented by sowing something that will grow and occupy the soil during the winter. Clover and rye are probably the best plants for the purpose. Clover would be better on good soils, while rye would be better on poor soils. The seed can be harrowed in on the turned soil. Rye can be grazed when the soil is not too wet, or cut and fed green, or it can be cut for hay in the spring. Clover could be cut for hay in early spring, but it would probably be better to turn both the clover and rye under in early spring to still more improve the soil. When pea vines are cut for hay it would be a good practice to turn under the stubble and harrow in rye or clover on the turned soil to protect it, and add more vegetable matter to it.

Sweet Potatoes.

Varieties. There are about forty or more varieties of sweet potatoes in cultivation, but many of them have no special merit. The Station tested in 1889 nine very common varieties, but since then the Vineless or bunch variety has attracted so much attention that I decided to test it in comparison with the common Yellow Yam. The place of origin of the vineless potato is supposed to be Columbus, Miss. The Vineless and Bunched varieties are the same.

The Vineless and Yellow Yam were planted at the two Branch Stations and yielded as follows:

Newport Station	Yellow Yam, 350 bushels per acre. Vineless, 262 bushels per acre.
Camden Station	Yellow Yam, 70 bushels per acre. Vineless, 90 bushels per acre.

The soil at Newport is more fertile than that at Camden, and the rainfall at Newport during the growing season was more favorable than at Camden, and those influences caused the difference in the yield at the two places. An unusually long summer drought prevailed at Camden this year, and was very serious in its effects on all vegetation, but the Vineless potato showed itself to be more capable of standing the drought than the Yellow Yam. When the Vineless has been tried elsewhere it has stood the drought extremely well. It has short, stocky vines, that are not over two feet in length. Leaves are heavy and very broad. The tubers are smooth and good sized, and their quality and flavor are excellent. The variety is earlier than the Yellow Yam, and its tuber when cooked may be described as soft, mealy and of yellowish color. The tubers are not as stringy, nor quite as sweet as the yellow yam. In the Newport test the vineless made less than half as much unmarketable tubers as did the Yellow Yam. In fact, all the Vineless tubers were marketable. The Vineless is a very fine potato, and its capacity for resisting drought, and especially its short growth of vine, make it a desirable potato for cultivation for table use and for stock. Its short vine enables easy cultivation and gathering with the plow, while with the long vine varieties cultivation is always difficult, and never possible with the plow except when the plants are very young, or when the vines are moved by hand to the top or to the opposite side of the row to the side where the plow runs. The Vineless sweet potato commends itself to the potato grower.

The sweet potato is such a valuable crop in the State for the table and for all live stock that a mention of a few important points concerning the crop may be useful. The inquiries received indicate that they would. Soils best suited to produce good yields of good, smooth potatoes, are sandy or sandy loams of moderate fertility. If the soil is rich, or contains a large supply of vegetable matter, the yield and quality of the tubers will not be satisfactory. As the sweet potato grows all summer, when nitrification is most active in the soil there is little use in supplying nitrogenous manure, but potash and acid phosphate are necessary fertilizers on poor soils.

Pruning or cutting off the vines is not an advisable practice, and will not increase the yield of rank growing potato plants. If the plants are on a suitable soil they will not go to "vines." Slips produce more and better potatoes than cut vines. Many of the numerous varieties of sweet potatoes have no special merit, and but little to distinguish them as a variety. Some of the chief distinguishing features of the most important varieties besides the leaves, which are the most reliable features of classification, are yield, earliness, the appearance of tubers, capacity to stand drought, and when cooked, color, flavor, sweetness, mealiness, watery, soft or hard. Some varieties when cooked are soft, mealy and not very sweet, such as the Early Jersey, while others are soft and sweet, like the Yellow Yam. The Vineless is mealy and not quite so sweet as the Yellow Yam. Still others are white, dry and mealy, but not very soft nor sweet, such as the Southern Queen and the Shanghai. The latter is late in maturing, while the Southern Queen is medium. The vineless and the Shanghai are both large yielders, but when cooked they are nearly opposite in quality. The dry, mealy potatoes, as market gardeners know, are preferred at the North to soft, sweet potatoes, while the latter are preferred at the South. All varieties improve in table quality after being dug for some time. Much difficulty is experienced by some in keeping sweet potatoes after gathering them. The two most essential features to be observed in keeping is not to dig before ripe, and to allow the tubers to sweat and dry out before covering with earth, or shutting off ventilation. The tubers should be dug soon after the first light frost, and the vines removed as soon as killed, if the tubers are not dug at once. The potatoes must be handled carefully to avoid bruising, and then piled in conical heaps on dry straw, and allowed to remain until they have *sweated* and dried out, before any covering of earth is put over them. When frost is expected, a cover of straw can be put on. If potatoes are covered with earth before they have throughly gone through this change they will surely rot. On the approach of colder weather straw or cornstalks should be laid smoothly on the heap or pile, then earth put on top of that in sufficient thickness to prevent frost reaching the tuber. The apex of the heap should remain open, except during extremely cold weather, to allow the escape of water and heat. A cover of boards should be built over the heaps to turn off water. Potatoes thus protected from rains are better for the table and keep better. The sweet potato is such a wholesome and nutritious food that it should be part of the bill of fare of every household. For live stock, and especially hogs, it is one of the very best foods.

Peanuts.

Peanuts are not grown in the State to any extent for either market or food for hogs, and yet the crop is very profitable for both purposes. If the peanut was properly grown on suitable soil, it could be made a profitable market crop. The Station grew them this year with a view of using them for hog feed, but as the crop offers profitable returns as a market crop, some discussion will be given the subject on that line. Two varieties were grown on the three Stations, and the average yield of the three places was 73 bushels of good selected nuts per acre, and at the average price that has been paid for them for several years in the large markets of Cincinnati and New Orleans, the crop would be profitable. The season of this year was not at all favorable for peanuts, especially at Camden and Fayetteville. The soil at each of the places where the nuts were planted was only medium in fertility.

Varieties. Three or four kinds of peanuts are grown. The red and white, so called from the color of the skin of the seed, large and small pods. The white variety commands a few cents a bushel more than the red, though it is said to be later and has more spreading habits than the red variety. There is another most excellent variety called the Spanish. It has a much smaller pod than the large market varieties, but yields abundantly, and its hardiness, earliness and upright growth make it especially valuable for hogs. The nuts are too small for market. Its upright growth allows close planting in the drill and cultivation with the plow. Its pods all grow clustered around the center of the vine and hogs find them without much trouble. When the vine is pulled up almost every pod comes up with it. The earliness of the variety enables it to mature its pods and therefore few "pops" are found. It is so very hardy that it will produce well on poor soil. For cultivation for hogs, to gather and feed on, it is preferable to the other varieties. In the trials on the Station last year the Virginia peanut and the Spanish were the varieties used. Their average yields at the three Stations were:

Spanish	73 bushels per acre.
Virginia	72 bushels per acre.

At Camden the soil was very poor and a prolonged drought occurred during the summer, and the Virginia variety made no mature nuts, but all "pops." The Spanish made a heavy yield of good nuts. At the two Stations, the Virginia variety exceeded the Spanish, but the Spanish was planted as far apart in the row as the Virginia, while it should have been planted only half as far, and in that event it would have produced as many bushels. The Spanish has a much smaller nut than the Virginia, and I determined the per cent of kernels to unshelled nuts of each variety after they had thoroughly dried. Spanish had 79 per cent of kernels in unshelled nuts. Virginia had 61 per cent of kernels in unshelled nuts, a difference of 18 per cent more food in a hundred pounds of Spanish than in a hundred pounds of Virginia.

Peanuts for market must be planted on light colored soil so that the pods will not be discolored. Any discoloration of the pods reduces their value very much. Soil best suited to peanuts is sandy or gravelly clay. Soils that contain much vegetable matter, or that are very rich, do not produce the best yield nor a good quality of nuts. The plant has in a high degree the capacity to procure its nitrogen from the air through the tubercular growths on its roots, and therefore does not require much if any nitrogenous manure. But like all legumes, mineral manures are especially beneficial, and potash and phosphoric acid should be applied to all poor soils. Lime is used to manure peanuts by farmers whose soils contain little or no lime. The seed are usually planted the last of April or in May. On well prepared soil the rows are laid off 3 feet apart, and peas planted closer on poor than on rich soils, and also much closer if the variety has an upright growth. Cultivation should be done shallow and as near level as possible, and without disturbing the vines after they begin to bloom. A scrape and a scooter make a good implement for cultivation. The vines should not be covered in the center with earth. When the nuts are grown for hog food, hogs can be turned in the field about frost time when the crop is about mature and has reached its maximum yield. The vines make excellent forage, equal to the best clover, and all live stock are fond of it. If the crop is grown for market and the vines are wanted for hay, the harvesting should be done just before frost. The vines are taken up after being loosened with a suitable plow that is run under them and below the nuts. They are then inverted and stacked one on top of another with a pole in the center if necessary, to hold them. When green the vines should not be packed too close, because they will heat. Care should be taken to grow and manage the nuts so that they will be well filled and have bright white hulls so as to secure good prices. When dry the sound nuts are picked off the vines without any "pops," because they reduce the value of the sound ones. Before sending the nuts to market they should be revolved in a cheap slat drum to remove all clay and earth and to polish the hulls. This one inexpensive precaution will insure a better price than if not done. The best market varieties do not hold all the pods attached to the vine when the vine is lifted out of the soil, so instead of growing a crop exclusively for hogs to gather, a good plan would be to pull up the vines before turning in the hogs, and sell the adhering nuts, and save the vines for hay, and allow the hogs to feed on the nuts left in the soil. The peanut being a leguminous plant, is but little exhaustive on the soil and is easily and cheaply grown, and could be made a profitable market crop on a suitable soil, and a most profitable one anywhere for hogs. New Orleans and Cincinnati are probably the best and most convenient markets, and consignments made to reliable commission men in those places will secure the best prices. There are no home markets, and it would be unwise to offer them for sale in places where there is no regular market for the crop.

Cotton.

Egyptian varieties were planted again this year both new seed and seed that grew upon the Station last year and the plants that grew from home seed did not differ from those grown from imported seed.

Crosses. Seed from the crosses made last year between the American and Egyptian varieties produced this year some very fine stalks that seemed to have retained the best qualities of both varieties. The seed will be planted again and an effort made to develop something of value.

American Varieties. About twenty-five well recommended varieties or so-called varieties have been grown on the Station and the following final statements are made of them: The cotton plant under favorable influences is very susceptible of improvement. Fertilization, cultivation and selection are necessary to improve or to keep a variety up to any high standard. The differences between many of the so-called varieties would disappear if they were cultivated alike under the same conditions for any length of time. But the differences between the different types such as long staple, short staple, long limb, short limb, and prolific remain for practically an indefinite time. Long staple varieties have always been in much favor with farmers mainly because of the extra price paid for the lint over that of short staples; but the relative prices of the two do not remain constant while the difference some seasons is very small. When it is considered that the long staples yield less than the short staples, especially on poor soils and during a *dry* year, the extra price paid for the long staple is seen to be more than overcome by the increased yield of the short staple and as the difference between the price of the two is very variable, the length of staple appears to be a matter of little practical consequence. In deciding what variety to plant on ordinary upland where conditions are not favorable to long staple or long period of growth, a short staple, early prolific variety is preferable and will be found in the main to be more profitable. On poor, dry soils, with improper cultivation, the long staple varieties are undesirable.

Jerusalem Artichokes.

Artichokes were grown at the three Stations this year to determine their value as a food for hogs. The trials at Camden were unsuccessful because of the poor soil on which they were planted and the long summer drought.

At Newport the yield was 453¾ bushels per acre, and at Fayetteville the yield was 612 bushels per acre. The distance between hills was 3 feet by 18 inches at Newport, and 3 feet by 3 feet at Fayetteville. The distance apart of hills less than 3 by 3 feet is too close and the large tops shade each other. The artichoke resembles a tall branched weed and late in the summer bright yellow flowers appear on the plant. The tubers grow closely clustered around the base of the root and are easily gathered or found by hogs. Artichokes are planted either with whole or cut tubers in hills not less than 3 by 3 feet apart. Cultivation is simple. The plant is very hardy, and will come after the first year from tubers left in the ground over winter. A fertile soil is necessary to secure the best yield and of course cultivation makes an increased yield. The tubers do not have to be dug. They keep perfectly in the ground all winter, and hogs can be turned in to root them about frost time as the crop will then have ceased growing. Hogs at first are not fond of the tubers, but soon learn to like them very much. They are excellent for range hogs. While artichokes yield abundantly and are of little or no trouble to grow and hogs are fond of them, they have never held much favor with hog raisers. Many farmers, however, prize them highly, while others condemn them as of little value. I have never seen them used on a large scale for range hogs. I confined a six months' pig that was being fed bran and corn, and fed it for two weeks on artichokes and a few peanuts, and naturally the artichokes were refused at first and only eaten sparingly during the first week, but during the second they were eaten very satisfactorily.

I give subjoined food analysis prepared by the Station chemist of artichokes, turnips, mangel-wurzels and sweet potatoes, all of which, except artichokes, are regarded as excellent food for hogs:

	Turnips.	Mangels.	Sweet Potatoes.	Artichokes.
Water	90.5	90.9	71.1	77.2
Ash	0 8	1.1	1.0	1.2
Crude Protein	1.1	1.4	1.5	2.4
Crude Fiber	1.2	0.9	1.3	.9
Ether Extract.	0.2	0.2	0.4	.2
N. Free Matter	6.2	5.5	24.7	18.1
	100.0	100.0	100.0	100.0
DRY MATTER.				
Ash	8.4	11.5	3.5	5.4
Crude Protein	12.4	15.2	5.2	10.6
Crude Fiber	12.2	9.5	3.6	4.0
Ether Extract	2.1	1.8	1.4	0.7
Nitrogen Free Matter	64.9	62.0	86.3	79.3
	100.0	100.0	100.0	100.0

The analysis shows that as far as the food contents of the artichoke is concerned it is by no means an inferior food. The chief merits of the plant for range hogs are its extreme hardiness and capacity to remain in the ground without rotting. The experience reported by some is that when the artichoke is once planted it is liable to be difficult to exterminate.

Turnips and Mangel-Wurzels.

Several varieties were grown this year to determine the heaviest yielders, with a view of using them as food for hogs and cattle. The following varieties of turnips were sown August 13: Long White Cow Horn, White Rutabaga, Early Red or Purple Top, Early White Egg, Yellow Aberdeen, Red-Topped White Globe, Sweet German, Yellow Globe or Amber, large White Norfolk, Seven Top, Early Purple-Topped Munich, Pomeranan White Globe, Purple Top Yellow Rutabaga, Southern Prize, Robertson's Golden Ball, Wood's Improved

Red Top Globe, Wood's Purple Top Rutabaga, Breadstone, Jersey Novite.

Of those varieties the largest yielders were Early Red Top, which has a small top and root; Early Purple Top Munich, which has a large top and flat root, and slightly tapering on under side; Red Top White Globe, has a large top and root, root tapering globe; it was the largest yielder; Early White Egg, small top, root medium size, egg shaped. Trials of mangel-wurzels were not satisfactory. The feed values of turnips and mangels are shown under "Artichokes." Turnips and mangels are good foods for growing hogs, and are good winter foods for cattle. Before freezing weather they can be plowed up and put in heaps in the field, and covered sufficiently with earth to prevent freezing, and then used for foods during winter to excellent advantage. The cost of growing and preserving them is very small, and when planted in the fall, crab grass and weeds have ceased growing, so little cultivation is required. The soil upon which they are sown must be fertile or well manured, otherwise the yield of root will be extremely light and unprofitable. Care must be exercised when banking the roots, in too much earth is not put on them at first, so that they cannot dry out. The thickness of covering should be increased as cold increases. Ventilation must be allowed when the roots are first banked, and for several weeks thereafter, and only stopped entirely during cold spells.

Foods for Hogs.

Preparatory to making some pork experiments, several varieties of different plants were grown at all the Stations this year to determine the best varieties of each as food for hogs. The several trials are reported in the preceding pages, and a brief statement of the best varieties of the different plants will be sufficient in this connection. The Spanish peanut when grown solely for hogs is the best variety to plant. The Whippoorwill cowpea, on account of its earliness, bunched growth and productiveness is probably the best. The Vineless sweet potato, on account of its productiveness, resistance to drought and lack of vines, is the best variety to grow for hogs. These three foods are the best cheap hog foods that can be grown at the South, and in feed value they are equal to any. Mangel-wurzels are heavier yielders than any other similar root, and are said to be better for hogs. Artichokes could be used to very profitable advantage for range hogs to feed on. With clover and rye for winter and spring grazing, red clover for spring, and Bermuda grass for summer pasture; sorghum, cowpeas, sweet potatoes and peanuts for fattening hogs, pork could be produced of unexcelled quality, and at a cost that would return the producer good profit.

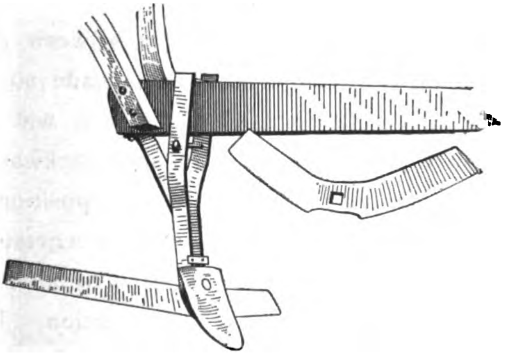
Heel Scrape and Scooter.

I have recommended the heel scrape and scooter as the best implement for level and shallow cultivation of crops grown in the State, and several letters have been received as to the nature and use of those implements. The following letter shows the nature of information wanted:

PLEASANT PLAINS, ARK., July 17, 1894.

I write this chiefly to know more about shallow cultivation. You speak of the scrape and scooter, and I understand how to make a scrape from your description, but do not understand what is meant by a scooter. I asked three of my neighbors and they were unable to inform me. This seems to indicate that there are a few others who are as ignorant on the subject as myself. Now, I suggest, if you please, that you describe the scooter in your next bulletin, and state whether you would use it in the first plowing, if so, about what length should it be and any other interesting details.

In view of the efficiency of the heel scrape for cultivating crops, especially cotton and corn, to destroy noxious vegetation and to mulch the soil to conserve moisture, I display below a cut of the two tools, attached to and detached from a single stock. They can be used on a walking cultivator just as well as on a single stock. The scrape can be attached under the scooter in front of the foot of the stock, but it does not run so level or satisfactory as when attached behind the heel of the foot. The depth of the furrow and inclination of the wings can be regulated by the back band, the foot of the plow where it is attached to the beam, and by the clevis. The clevis should be moved first when necessary to regulate the scrape. The scrapes shown in the cut are 16 and 24 inches long and 2¾ inches wide. The scooter is 7 inches long and 3½ inches wide. I think when the



HEEL SCRAPE AND SCOOTER.

scrape and scooter are once used and understood, they will supersede other more expensive and less effective plows now in general use in the State for cultivating crops.

I have taken from bulletin 27 a description of the scrape and how to make it.

The Scrape and Scooter.—I have found them when used together to be one of the best implements for shallow cultivation of corn and cotton. They can be attached to a single stock or to a cultivator. The scrape can be made any length, and for all plowing after the first they are used from eighteen to twenty-four inches long, that is, they will cut that width of surface. The scrape should run level, and is held steadily in the ground by the short scooter. The best work is done when the scrape is attached to the heel of the foot. They are inexpensive, easily sharpened, of light draft and do the most efficient work. If the scrape is not found in all small markets it can be easily made in any blacksmith shop. A piece of steel about one-quarter of an inch thick and about two and one-half inches wide, and cut to any length desired, is sufficient. One edge is sharpened, a hole made in the middle for the heel bolt, and from about one to one and a half inches on each side of the center of the hole bend the two ends back to an angle between 30 and 35 degrees. The cutting edge should be made so that when placed upon a level surface all parts of it will touch the surface. The top edge is then inclined backward so as to place the lower cutting edge in a cutting position. In this shape the scrape easily cuts all tap-rooted vegetation and at the same time lifts the soil, allowing it to fall over behind the scrape in a thoroughly pulverized condition. By the use of a long scrape, when corn and cotton are advanced in growth, cultivation can be done close to the stalks without breaking the limbs, and the short scooter is far enough off so as not to disturb any large roots. With it two furrows will thoroughly cultivate each middle, leaving no ridge of soil, but instead a level surface. The scrape is so effective in its work that when used a greater part of the costly and unbeneficial hoeing is avoided.

Cultivation of crops is not done to break the soil, for it is presumed the soil was thoroughly broken before planting. If, however, rains or other agencies harden or pack the soil after planting, the rebreaking should be done at the first working and not afterwards. The essential things in cultivating crops are to prevent grass and weeds from growing and to keep the surface soil in good tilth or mulched with loose earth. To accomplish these things deep plowing is not only unnecessary, but harmful. In cultivation only the surface soil should be worked, and implements used that will do that thoroughly. If soils are well drained the seed bed should be low to allow level and shallow culture. When the beds are high, deep and high cultivation is almost unavoidable. Besides the importance to the crop of shallow and level culture, the easier draft and speed obtained in it is also important.

R. L. BENNETT,
Agriculturist.
G. B. IRBY,
Assistant.

WEATHER RECORD AT NEWPORT EXPERIMENT STATION FOR SEASON OF 1894.

APRIL.				MAY.				JUNE.				JULY.				AUGUST.				SEPT.				OCT.			
Date.	Maximum Temp.	Minimum Temp.	Rain in Inches.	Date.	Maximum Temp	Minimum Temp.	Rain in Inches.	Date.	Maximum Temp.	Minimum Temp.	Rain in Inches.	Date.	Maximum Temp.	Minimum Temp.	Rain in Inches.	Date.	Maximum Temp.	Minimum Temp.	Rain in Inches.	Date.	Maximum Temp.	Minimum Temp.	Rain in Inches.	Date.	Maximum Temp.	Minimum Temp.	Rain in Inches.
1	68	50	.56	1	80	60	1.51	1	75	47	.....	1	100	71	.09	1	92	70	.....	1	88	65	.....	1	78	43	.....
2	69	39	.....	2	85	63	....	2	84	52	.....	2	95	64	.....	2	82	67	.25	2	83	66	.06	2	82	...	.....
3	68	52	.16	3	83	63	.16	3	86	57	.....	3	95	70	.....	3	84	68	....	3	90	70	.....	3	79	57	.69
4	69	44	1.01	4	82	63	.07	4	86	59	.....	4	86	71	.....	4	78	62	.....	4	87	70	.14	4	72	52	.....
5	69	44	....	5	77	64	.....	5	83	62	.33	5	80	62	4.55	5	80	54	.....	5	91	68	.....	5	73	44	.....
6	66	37*	.....	6	82	65	.....	6	70	54	.08	6	85	69	....	6	86	53	.....	6	90	67	.....	6	...	...	.....
7	75	49	.30	7	87	62	.68	7	72	46	.....	7	85	65	.....	7	85	61	.....	7	89	67	.....	7	76	45	.....
8	72	50	.....	8	75	62	1.02	8	80	50	....	8	74	67	.....	8	91	65	.....	8	..	...	.....	8	...	...	.....
9	69	54	.38	9	83	64	.03	9	87	..	.....	9	82	62	.....	9	93	67	.....	9	93	68	.53	9	..	...	frost
10	65	41	.01	10	82	66	.33	10	89	61	.....	10	85	60	....	10	93	68	.....	10	81	67	.60	10	76	31	“
11	69	41	.....	11	67	57	....	11	90	64	.....	11	86	60	.. ..	11	87	73	.....	11	74	58	.....	11	...	...	......
12	65	41	.....	12	76	52	.. ...	12	89	65	.....	12	88	60	.....	12	97	67	.....	12	67	58	.75	12	74	36	.28
13	70	45	....	13	84	61	...	13	89	65	.....	13	90	64	......	13	97	69	.....	13	85	63	......	13	69	42	......
14	68	50	.52	14	86	65	......	14	90	62	.81	14	92	66	.....	14	98	70	.01	14	87	68	.12	14	67	33	......
15	77	51	.11	15	85	64	......	15	88	63	.11	15	83	66	.47	15	98	74	....	15	79	69	.09	15	72	38	......
16	80	60	....	16	86	67	.....	16	85	66	......	16	87	65	.....	16	94	70	.....	16	83	64	.....	16	81	39	.....
17	82	64	.14	17	88	66	....	17	86	68	.16	17	85	65	.....	17	94	68	.....	17	80	64	....	17	86	45	....
18	81	62	.40	18	82	57	.06	18	86	65	1.13	18	86	65	....	18	93	66	... .	18	80	58	....	18	82	48	.....
19	74	57	.34	19	63	43	....	19	89	65	.....	19	73	65	.93	19	95	65	....	19	77	50	.....	19	84	54	.....
20	67	50	.....	20	71	41	......	20	90	67	.....	20	84	64	......	20	91	64	.....	20	81	53	....	20	84	56	.....
21	59	44	.....	21	68	43	.....	21	88	68	....	21	81	68	.15	21	80	68	.02	21	82	53	....	21	80	58	.....
22	71	39*	.....	22	67	52	.....	22	89	69	.....	22	82	61	....	22	79	66	.02	22	87	61	.....	22	86	51	.....
23	68	49	....	23	72	54	.13	23	90	68	.....	23	86	60	......	23	75	65	.08	23	88	67	.....	23	88	46	.....
24	69	52	.....	24	73	54	.....	24	91	61	.....	24	89	58	.....	24	78	65	1.17	24	74	55	.09	24	83	47	... ..
25	72	45	....	25	73	53	.14	25	90	70	.....	25	90	67	.....	25	83	64	......	25	72	48	......	25	75	44	.....
26	79	45	....	26	80	53	....	26	90	73	....	26	90	65	.....	26	82	67	.50	26	79	43	.....	26	76	40	......
27	81	51	.....	27	85	54	.05	27	91	75	.....	27	89	66	.....	27	85	66	....	27	84	46	....	27	73	38	......
28	83	57	.....	28	75	60	.06	28	94	72	....	28	84	66	....	28	86	65	....	28	84	48	.....	28	75	43	......
29	86	60	.....	29	70	55	.35	29	98½	71	.....	29	89	66	....	29	89	65	....	29	84	47	.....	29	71	43	.28
30	83	66	.....	30	70	57	2.21	30	98	70	.....	30	92	67	....	30	90	65	....	30	77	57	......	30	58	36	......
...	...	....	.....	31	66	52	.02	..	....	...	....	31	94	68	....	31	90	65	....	..	..	...	....	31	70	28	......

*Frost.

Weather table was prepared by G. B. Irby, Assistant Agriculturist and Observer at Newport Station.

Farm Drainage.

As stated in Bulletin 28, the Southern Branch Arkansas Agricultural Experiment Station "consists of comparatively level uplands, hillsides and wet lowlands, the characters of soil so prevalent in the southern third of the State." The almost total neglect of protection from washing of hillsides and of reclamation of wet lowlands in south and east Arkansas, suggested the writing of this bulletin. It is not however intended that it shall even approach to being an exhaustive treatise on farm drainage, but it is hoped that it will contain statements and suggestions from which persons owning such lands may derive benefit.

Uplands must be protected from washing to maintain their fertility and also when efforts are made to restore their fertility, but, besides the need of protection by the cultivated uplands the large areas of fertile lowland in the State, especially in the east and south parts, that remain idle because they are too wet to cultivate, but that can be easily drained and made tillable, are alone sufficient to make this bulletin timely and useful.

No one division of agricultural science is so greatly neglected in south and east Arkansas as farm drainage, and to a very great extent this is true throughout the South. A very large proportion of Arkansas is hillsides and bottoms. Under hillsides is included such sloping soil as is subject to washing from rainfall, and by bottoms is meant such low grounds that during any portion of the year contain a superabundance of water.

It is no uncommon sight throughout the South to see hillsides corrugated with gullies and from which their once fertile soil has been removed to the stagnant, malaria-producing bottoms below. By injudicious methods of culture rains become, not so much the indispensable agencies of plant growth, but soil-robbers of plant food—removing the elements and conditions necessary to the production of remunerative crops to the marshes along the water courses.

The object then of this bulletin is to give brief suggestions as to how hillsides may be protected from this loss of soil and plant food, and the bottoms made to give in the form of plant growth their rich stores of plant food which they contain, but in an unavailable form.

The rainwater that falls upon the surface of the earth may be divided into four parts:

1. That which flows immediately off and causes the rise in the rivers and smaller streams.

2. That which sinks into the soil but reappears as springs to give the regular (or irregular) supply to streams.

3. That which reaches the sea by subterranean channels; and

4. That which evaporates from the surface of the soil.

It is with the first two of these that we are concerned. Their damaging effects are opposed to each other, inasmuch as the first by its surface flow erodes, while the second by its imperfect flow supersaturates the soil. These supersaturated soils are, as a rule, produced by the erosive effects of rainwater, being brought down from more elevated ground and deposited on either side of the water course. The position of such soils and the mechanical arrangement of the particles of matter composing them admits of but slow percolation of water reaching them from the adjacent hills. These deposits, although rich in vegetable and mineral plant food, are incapable of profitable cultivation so long as they contain an excess of water, and this latent plant food is yearly being increased at the expense of soil more elevated.

For the sake of convenience the subject is divided into:

a. Protection of Soil from Surface Washing.

b. Drainage of Wet Lands.

Protection of Soil from Surface Washing.

It is seldom that we find much evidence of erosion on soil other than that which has been or is in cultivation. In its natural state the surface is covered with vegetation, the roots and fallen leaves and twigs of which together with the small plants that spread themselves upon the surface effectually hold the soil in its place. Furthermore, the plant covering not only improves the mechanical condition of the soil by keeping it loose and porous and retaining moisture, but also returns to the soil by its annual decay those elements of fertility required in its growth, that these elements may in turn be used by future plants. In cultivation this natural covering must be removed, the roots broken and the surface made loose that planted crops may grow. In this condition the nude soil is readily washed and especially so if sandy and crops requiring clean cultivation are grown without rotation with such crops as occupy the entire surface, as grain and grasses. Heavy rains, aside from removing largely of the store of soluble plant food, also remove the dead vegetable matter upon the surface of the soil. This dead matter is an important factor of fertility, particularly on light and sandy soil, benefiting it both physically and chemically. This is preëminently true in the cotton growing States where rotation of crops is seldom practiced and clean culture always attempted. It is very probable that the cultivated land of no section of the United States suffers so much from surface washing as do the Cotton States. This is attributable to the natural geological characteristics of the soil, to the methods most generally practiced in the cultivation of cotton—the staple crop—the absence of rotation of crops and the quality or inefficientness of the laborer. Regarding the methods of culture practiced, there are three things that hasten the surface washing of cotton fields, *i. e.*, clean culture, high beds and disregard of the laying off of the rows on a level. Clean culture is proper and even necessary to obtain the best results. High beds are not necessary, as experiments in every Cotton State have proven, and should be superceded by flat culture. While flat culture of cotton has many advantages over the high bed system there is only one point in favor of the high beds—they hasten the drying off of *wet* lands. But it is the combination of two soils that causes the greatest washing away of the soil and the cutting into gullies so noticable in the cotton field. These evils are high beds for rows and rows not run on a level, but up hill and down hill with no idea of conformity to the slope of the field. An example of the effects of these evils may be found in nearly every cotton field (if the field is not level), in two elevated areas with a depression between and rows running down one side, across the depression and up the other side. In heavy rains the middle of each row carries its water to the lowest point (washing as it is carried), where it breaks across the row, uniting with the water from other rows and a gully is formed to be deepened and widened by each subsequent rain. Thus more plant food is removed by fallen rainwater than is removed by the growing crop. The soil thus becomes rapidly exhausted, and is often "turned out to rest." A soil thus taking its rest is given by nature not only a diversity of crops, but rotation. The first year rag weed, crab grass and poor Joe are most abundant. The second year broom sedge, biennial evening primroses, thoroughworts, and possibly briars appear, while the rag weeds and crab grass are not so plentiful as the first year. Thus every year or two there is a dominant plant or plants which in turn become subordinate and others appear and become dominant. Finally a pine or sweet gum or cotton wood thicket appears to in turn give way to the original forest growth, whatever that might have been. In the meanwhile the soil has been built up until it possesses almost, if not quite, its original fertility.

Two methods of drainage are practiced for the protection of soil from washing and at the same time preserve its fertility. They are hillside ditching and terracing. Neither completely prevents surface washing, but diminishes it. Both have advantages and disadvantages, and as to whether a hillside ditch or a terrace should be built must be determined by the character of the soil to be treated and other local circumstances and conditions, but in a very large majority of cases terraces are preferable when properly constructed and given the proper after treatment.

HILLSIDE DITCHES.

A hillside ditch is a ditch running around sloping ground with a slight but regular fall, that the surplus water may be removed slowly carrying with it as little soil as possible.

The water falling on a hillside is divided into as many parts as there are hillside ditches, each ditch carrying off its allotted part.

The erosive and transporting power of flowing water increases geometrically as its volume increases and geometrically again as its velocity is increased. "If the surface of the obstacle is constant the force of running water varies as the velocity squared: $f \propto V^2$. This may be easily proved. Suppose we have an obstacle like the pier of a bridge standing in water running with a given velocity. Now, if from any cause the velocity of the current be *doubled*, since momentum or force is equal to quantity of matter multiplied by velocity ($M = Q \times V$), the force of the current will be quadrupled, for there will be double the quantity of water striking the pier in a given time with double the velocity. If the velocity of the current be trebled, there will be three times the quantity of water striking with three times the velocity, and the force will be increased nine times. If the velocity be quadrupled the force is increased sixteen times, and so on." The advantage then of conveying the surplus water from the surface of the soil with a slow velocity and in small quantities is apparent. Properly constructed hillside ditches do this but not so perfectly as terraces. If not properly constructed they defeat their object by being aids both to erosion and transportation. Practice and experience teach that hillside ditches are superior to terraces under only two conditions or circumstances, namely: 1. When the surface water to be controlled reaches the area to be protected in damaging quantities from adjacent property; and 2. When the soil of the area to be protected is mechanically very light and loose and easily portable under the influence of flowing water and the natural slope of the field is great.

Before locating the ditch the ground should be gone over carefully and studied that the location may be properly made. If it is desirable that the ditch should pass any particular point, begin laying off at that point and lay off first one and then the other way, if the starting point is not at one or the other end of the ditch. An accurate level* and graduated rod should be used in laying off the line along which the ditch is to be built. To run this line properly is of vital importance in hillside ditching, inasmuch as it both determines the position and fall of the ditch. The suggestions for laying off terraces (p. 42) apply equally well for hillside ditches with the exception of the fall, and greater accuracy and uniformity will be secured by first staking the line as for a terrace, and giving the fall as desired from this line which is used as a base. Suppose this level base line has been established and the fall desired was 4 inches in every 100 feet. The level is adjusted and brought to bear on the rod target, the rod being placed perpendicular on this level line and where the ditch is to begin. Measure 100 feet along base line (from first station), raise target 4 inches and holding rod perpendicular move it down hill (from point on base line 100 feet from first station) until the target again comes on level with instrument, instrument not having been moved from first station. Stakes must be driven in the ground at the beginning of the ditch and at every station to mark the ditch line. The next 100 feet are measured, target raised 4 more inches, etc., to the end of the ditch. If the slope of the ground or the length of the ditch requires that the instrument be reset, it should, in being reset, be adjusted to the target, while the rod is placed at the station last made, and then proceed as at first. The above instructions are for laying off the ditch from source to mouth. If the laying off begins at the mouth and proceeds to the source the target must be *lowered* 4 inches in every 100 feet. If the ditch is marked off *up the ditch* the target is lowered; if *down the ditch* the target is raised. Remembering this the ditch may be laid off by beginning at any point on the level line used as a base and run equally well either way from this point, by lowering the target when going up the ditch and raising it when going down. The ditch may be laid off without the establishment of the base line referred to, but in practice it will be found that by this method the work can be quickly done and accuracy is easily secured. Another way that secures accuracy, but is not always so practical, is with a cord 100 feet long, one end of which is at the first station stake and the other tied to the rod. By stretching this cord taut in the direction of the ditch and adjusting target to instrument the next station may be determined and staked. The end of the cord is then removed from the first to this, the second stake, and the rod is carried forward and the other stations in like manner located. Ditches cannot thus be laid off, however, unless the field is clear of obstacles that would interfere with the stretching of the cord.

---

*See Appendix for descriptions of a cheap and useful level and cost of levels.

Where elevations or depressions are sharp and occur between these 100 foot stations it is often necessary that the stakes serving as guides for the course of the ditch be nearer together, that the fall in the curve of the ditch may be properly graded. In such cases stakes should be put down every 25 feet, and a fall of one-fourth that given for 100 feet allowed for every 25 foot station.

Should it become necessary to cross a gully or other abrupt depressions a well built dam must be constructed and made to connect the ditch lines on either side. The dam should at first be higher than the ditch banks on either side of the gully, as the greater quantity of loose earth composing the dam will settle when wet, and if not well built may break during a rain from the pressure of the collected water above. The depression above the dam will soon fill up to the level of the bottom of the ditch and thus strengthen the dam.

Having laid off the ditch properly and dammed the old ditches or gullies crossing it, the next step is to throw up the ditch bank. For this work the hillside or *reversible* plow is almost indispensable. This plow is so arranged that it can be instantly changed to either right or left hand. Should none be available it is economy to do the work with an ordinary turning plow, throwing all the soil down hill; but of course this must be done by running one furrow and then dragging the plow back for the next. Even with the loss of every other furrow one plow can do many times more work per day than can be done with shovel or hoe. The first furrow in throwing up the ditch bank should be eight or twelve inches from the stakes and up hill from them, the soil being thrown down hill. This leaves the stakes as they were put down in laying off the ditch that they may serve as guides in correcting irregularities in the construction of the ditch. The first furrow should be carefully run. In fact it is better to run twice or three times in this furrow before running the second. The soil of the second furrow fills the first, the third fills the second and so on. Having plowed furrows sufficient to make the ditch as wide as desired, the plow is again run in the first furrow (which is now filled with earth removed from the second), then in the second again, and so on until the ditch bank is as high as desired. Each time the plow is run the earth is moved one furrow down hill and at the same time piled one furrow higher on the ditch bank. A few rounds of the plow in average soil will make a bank 18 or 24 inches high. The loose earth remaining after the work with plow is completed is pulled out with hoe or thrown out with shovel and used to correct the irregularities of the bank made with plow.

This completes the construction of the hillside ditch, but they require constant care and attention and particularly the first year, as the bank has not yet become compact and may be broken by heavy rains. They should be examined after each rain and cleared of anything that might have found its way into the ditch and would obstruct the flow of water. It is an advantage to have grass growing in the bottom of the ditch, provided the growth does not become rank, for rank growth of any kind is seriously objectionable, collecting trash and earth and often causing an overflow or break. The bank should always have something growing on it. Nothing is better than Bermuda, and crab grass is good the first year. Rye, barley, crimson clover and winter vetch make good protection during winter if sown in September or October. Moles and the pocket gopher are great enemies to hillside ditches and terraces, and unless gotten rid of trouble may be expected from them.

The *actual* distance between one hillside ditch and another of course varies with the fall of the land. The steeper the land the nearer they will be together and the more nearly level the further apart, but they should have 3 feet of *perpendicular* fall between the ditches. The fall or descent of the ditch itself should not be over 6 inches to the 100 feet, and rarely should as much as 5 inches be given for that distance. It is better to have a broad ditch or a high bank than one with fall sufficient to carry off the water at a high velocity. On the Southern Branch Station is a hillside ditch above a road, both of which extend very nearly through the greater length of the Station property. This ditch is 350 yards long and the fall is only 2½ inches per 100 feet or 26¼ inches in the entire ditch. It gave some trouble by overflowing before the road became compact and the fall perfected, but now works beautifully when free from obstructions. When nearly full the water in this ditch flows with a velocity of above five miles per hour, requiring brisk walking to keep up with the current. Both the ditch and the road are well sodded in Bermuda. Neither the bottom nor the sides of the ditch wash at any place throughout its length, and very little sediment is deposited in the bottom.

TERRACES.

The theory of terraces, which has been sustained by experience, is that it prevents the water which falls upon the land from collecting into rivulets having force enough to do mischief, and causes it to remain longer on the soil as the terrace spaces become gradually leveled by successive plowings; and compels that which does flow off to go spread in sheets as from the eaves of a house roof, instead of in collected quantities as from the valleys of the roof. The water that does not soak into the earth is carried from the field spread uniformly over its surface and with a checked velocity, thus decreasing its washing effect geometrically as its velocity is retarded and geometrically again as it is more uniformly spread. Some give a slight fall to the terrace line and others throw up a bank with a ditch above. Both are objectionable and totally inconsistent with the fundamental idea of the terrace. The bank proves terribly destructive and has caused much prejudice against terracing. The mischief is done by the breaking of the bank and turning loose the pond which has collected above. Such a so-called terrace is nothing more nor less than a hillside ditch improperly constructed.

To lay off a terrace a starting point is selected either above or below any comparatively level part of the hillside so as to cut such level as little as possible. If there is no such level to be protected it matters little where the starting point is taken. Absolutely level lines are laid off around the hill and staked, placing the stakes nearer if the curve is sharp to preserve the level when plowing. If the slope is uniform and the curvature slight the stakes may not be so near each other. If there are old gullies or other decided local depressions or elevations to be crossed by the terrace, let stakes be placed near the edge on each side to avoid sudden bends in the line. These gullies and other sharp local depressions must be filled and the terrace line where it crosses them be strongly fortified before plowing commences. This is greatly facilitated by plowing up one side and down the other with turning plow throwing the furrows into the ditch. After plowing and replowing several times in this manner the gullies can be greatly leveled, even when originally 3 or 4 feet deep. The terrace lines, which are designated by the rows of stakes, are at no time to be broken, but soil not less than the width of the plow slice must be left with the stakes. In plowing the spaces between the terrace lines begin one furrow width above the lower line throwing the plow slice upon the unbroken space. Continue returning upon the furrows, throwing each plow slice down hill with *hillside* or *reversible* plow until the next terrace line above is reached, leaving the last furrow below the next terrace line open. Unless the two adjacent terrace lines are parallel, which is rarely the case, there will be short furrows to break below the terrace line.

Before plowing these short furrows it is well to plow the first furrow above the next terrace line that it may be used as a guide in plowing out the short furrows and that the terrace line may not accidently be broken. This is only necessary when the terrace is being plowed the first time. If there is unterraced land above from which the water will flow upon the land being terraced, its flow must be arrested by a ditch so laid off and constructed as to collect and carry this water around the terrace, otherwise gullies may be cut across the terraces by the first washing rain.

The fall between two terrace lines, or the vertical elevation of one terrace line above the line below, should be 3 feet, and this fall will be accurately preserved when the terraces are laid off on a perfect level, as should invariably be the case.

After the terraces are once correctly formed and grass grows upon them, they are of no further trouble, but take care of themselves. If the terraces are made in fall or winter, it will be of very great advantage to sow terrace line thick with rye, or with oats if they are made in the early spring. This covering of vegetation will be valuable for holding the terrace lines until they become covered with the native grasses and weeds which appear later and serve the same purpose. German clover may be substituted for rye if planted in late summer or early fall. In sowing the seed, whether rye, barley, oats, or clover, it is a good plan to first sow thickly on the unbroken terrace line. This sowing will be covered by the first furrow above. Sow again on the loose soil of this furrow and cover with the second furrow. Alfalfa and melilotus will answer the above purpose where these plants thrive without much attention and on strong soil would afford protection both summer and winter.

Terrace lines serve as a valuable guide in laying off rows for planting. These lines will not be equidistant throughout their lengths and there must be short rows in the terraces. Lay off the rows alternately from the upper and lower margins until they meet at the narrowest part and then finish the space with short rows, laying them off alternately as before. Rows thus laid off are themselves miniature terraces and materially aid the regular ones in performing their function. The objections to terraces are the greater difficulty in the use of improved machinery, in hauling and the increased number of short rows, all of which is insignificant when compared with their benefits.

In portions of Georgia and Alabama where the proper system of terracing is largely practiced, immense areas that once were considered "worn out" and incapable of profitable yield, now produce crops as large as were gathered when the same areas were "new ground," and in many instances where a judicious system of crop rotation and proper culture are practiced, the yield is greater than ever before.

To avoid trouble and disaster to those who may construct terraces or hillside ditches, this cautionary statement is made—that the work must be properly and thoroughly done. This statement applies to all kinds of farm drainage.

Drainage of Wet Lands.

The little drainage practiced in south and east Arkansas is so inefficiently done that but slight opportunity is afforded to illustrate the benefit and profit accruing from the proper execution of the work. Many acres of land that could be drained with but little cost are now allowed to lie idle, the owners preferring to cultivate the less fertile upland. Many of these wet lands will pay the cost of drainage the first or second year and give double the yield per acre that is being gathered from areas believed not to be in need of drainage.

The benefits of drainage were very forcibly illustrated during the present year ('94) on the Southern Branch Station. There was gathered from one and one-fifth acres 39 bushels of corn. The land had never before been in cultivation and a portion of it remained under water during the entire summer of '93. The whole area was boggy and covered with a growth of such plants as are commonly found growing in and around marshes. About 10 cords of willow, sweet gum and black gum wood was taken off and the coarse trash either removed or burned. A small, open ditch was first dug to drain the surface water. A main and two lateral ditches were staked off, the total length of which was 135 yards. These ditches, where stumps and roots did not interfere, were opened to a depth of from 12 to 18 inches with a large turning plow and further deepened to 30 or 36 inches with shovel, giving a fall of about 5 inches to every 100 feet. Into these ditches were placed inverted V shaped troughs, made of cypress plank, 6 inches wide, 1 inch thick and 16 feet long. The ditches were then filled partly with shovel and partly with turning plow. The total cost of the ditch, including digging, plank, nails and filling, did not exceed $10. Not one-tenth of the land thus drained (1 1-5 acres) could have been cultivated at all without drainage, but underdrained it produced 39 bushels of corn the *first year* without fertilizer, while upland not 200 yards distant failed to yield 10 bushels fertilized with 200 pounds of cotton seed meal and given twice the amount of cultivation. No water now remains on any portion of the drained area referred to more than an hour or two after the heaviest rain. In fact, it is the dryest ground on the Station property after a heavy rain and the most moist during a drouth.

INDICATIONS OF THE NEED OF DRAINAGE.

The roots of all cultivated plants extend down to a depth of 3 or 4 feet and under favorable circumstances deeper. The roots, will not, however, grow in water. If the soil remains saturated to within 12 inches of the surface the roots will not penetrate to a depth greater than 12 inches. The roots of cultivated plants must be in air as well as the tops. Unless excluded by water, air will penetrate the earth to a depth greater than that attained by the roots of any cultivated plant. That cultivated plants may be profitably grown the water should not remain for any length of time nearer the surface than 3 feet. The depth of a water table (or the height to which water stands in the soil) can be determined in several ways, and when found to remain nearer the surface than 3 feet the soil will be greatly benefited by drainage.

Among the indications of the need of drainage are:

(a) Swamps.
(b) Certain plants that grow on wet ground.
(c) Wide cracks on surface in dry weather.
(d) Water in pits or standing on surface.
(e) Soil remaining wet long after rain.
(f) Stagnant water within three feet of surface.

The presence of any one of these indications is sufficient evidence of a decided need of drainage, and as a rule it would be *profitable* to drain land with the evidence of the presence of even one of these indications. It has been written "that all lands which are worth plowing, which is not the case with all lands that are plowed, would be *improved* by drainage." But it does not necessarily follow that all lands worth plowing may be *profitably* drained. It is a fact, however, that thousands of acres of cultivated Arkansas lands would, if properly drained, give double their present yield, and thousands more not cultivated, on account of their being too wet, would, if drained, yield double or treble as much as the average acre now in cultivation.

(a) Swamps. In traveling through south Arkansas either by rail or dirt road it rarely occurs that one or more swamps are not always in sight. In their natural condition they are not only unfit for cultivation, but dangerous to health from the miasmata arising from them and polluting the surrounding atmosphere. Those who have successfully undertaken the reclamation of these swamps will bear witness to the fact of their being the most fertile lands in south Arkansas with the possible exception of the most fertile of the river bottoms. In their natural state these swamps are covered or bordered with a heavy growth of timber which is frequently woven together with a net-work of many species of vines. They usually lie on either side of streams and are lower than the surrounding country. These swamps are the dumping ground of the adjacent areas and their soil is composed of the light and finer portions of higher soils brought down by rains and intermixed with the decay-

ing and decayed vegetation that has grown in the swamp itself and that has been brought by wind and water from more elevated areas from ages past to the present time. These deposits vary in depth from a few inches to many feet.

The most prolific source of failures in the drainage of these swamps lies in not putting the drains in the proper place and not making them deep enough. The first step to be taken is to ascertain how the land is made too wet. It may be made too wet by the impeded flow of a stream passing through it; by the direct fall of rainwater; by rainwater flowing from the hills, or by springs at the margin of the swamps or rising from below.

Usually a stream flows through such swamps at their lowest level. To clean out, straighten and deepen this natural drain is usually the first thing to be done, but it is only occasionally that this will effectually drain the swamp. It may be effectual for a few feet on either side of the drain, but the water that reaches the swamp at its edges, whether surface or subterranean, must seap through the sides of the area before it reaches the central drain. Such swamps are found to be wettest around their edges. This condition must be remedied by a deep open ditch with sloping banks cut around the margin of the swamp to intercept the flow from the adjacant more elevated soil. This ditch should, as near as practicable, conform to the margin and be emptied into the central drain at some point below. If this lateral flow of water is not too great during heavy rains an underdrain or covered ditch would be as effectual as an open one and far more preferable and economical. After the construction of the central and marginal drains it is often found that between them are wet spots or even springs receiving their supply of water from distant sources, conveyed to them by channels deeper than the marginal drains and the shallow marginal springs. The water of these deep springs is often pure and cold and good for use. They should be drained by a covered drain cut straight to them from the central or marginal drains and sufficiently deep to dry the surface.

When the excess of water in low lands is due to the direct fall of rain it should be removed by underdrains laid at intervals of from 40 to 60 feet.

(*b*) *Certain plants that grow on wet ground.*

It frequently occurs that certain areas of land have the surface appearance of being sufficiently well drained naturally, but under cultivation do not yield profitable crops. Such areas are usually covered with a deposit of sand varying in depth from a few inches to a few feet and through which the water readily percolates from the surface. Such areas are, in reality, sand covered swamps. An inspection of the natural vegetable growth will indicate this. Grasses, sedges, rushes and various other plants known to delight in wet places will be a sure indication of the saturated condition of the soil beneath the surface. Alder, button bush, cypress, maple and gums are indicators of the same condition, particularly the first three mentioned. Such lands are, in reality, swamps, though not commonly so considered, and should have applied to them the same drainage as swamps.

(*c*) *Wide cracks on surface in dry weather.*

(*d*) *Water in pits or standing on surface.*

(*e*) *Soil remaining wet long after rain.*

(*f*) *Stagnant water within 3 feet of surface.*

The indications of the needs of drainage spoken of under *a* and *b* are for such soils as may be classed as permanently wet. Others are periodically wet to a degree rendering the cultivation of crops unprofitable, and may be in bottoms, on hillsides, hilltops or anywhere between these three locations. The owners of such lands generally recognize in them a defect, but do not always attribute it to the need of drainage, nor would drainage in all cases be profitable, but the drainage of such lands is far more profitable than their owners believe. Wide cracks in the surface of any soil is a sure indication of the presence, for some length of time, of an excess of water, and of its rapid evaporation from the surface while the soil is still wet beneath. If in surface pits or depressions of surface irregularities water remains after rain, or if the soil is wet or if there is stagnant or other water within 3 feet of surface, the soil needs drainage. A sure and easy way to determine how near the surface and how long water stands in the soil is to sink a hole 3 feet deep and 8 or 12 inches wide. The height to which the water rises in such a hole is the height at which it stands in the soil, or nearly so, for capillary attraction raises it in the soil nearer the surface than the water level in the hole.

OPEN DITCHES.

In the removal of water from wet lands open ditches bear somewhat the relation to underdrains that hillside ditches bear to terraces. Unless the circumstances are such as to require it, an open ditch should never occur on a farm, but underdrains of one kind or another should take its place. If the soil is hilly and the water comes down in large quantities after heavy rains, an open ditch is necessary; or, if the area to be ditched receives the drainage water from a considerable area above, the quantity of water coming down must be conveyed off by an open ditch. At their best open ditches are not permanent and require constant attention and are in reality very expensive in the long run. Great care should be given the slope of their banks and the fall of the bottoms. If the banks are not given the proper slope they will be apt to cave in, thus obstructing the water flow and defeating the object of the ditch. The slope should be between 30° and 40°, or about that given railroad embankments, which is the slope the earth naturally assumes and endures longer under natural conditions. In some cases the slope may be lower than the natural slope and sufficiently low to permit hauling across the ditches. In such a case the ditch should be permanently sodded in grass and kept free from ranker growth that would catch trash and soil, and obstruct the water flow. The fall should be regular and not too great, otherwise deepening in some places and widening in others will be the result. This deepening and widening is a serious objection and hindrance to open ditches in soil of the character prevalent in south Arkansas. There are many objections to open ditches as compared to underdrains. The digging of a ditch with sloping banks is more expensive and difficult than digging an upright one as is made for underdrains, and the open ditch to be kept in working order must be cleaned out at least once a year and frequently several times. The earth taken from an open ditch must be removed or it will obstruct the entrance of water and be prolific in the growth of briars, bushes and weeds. Thus open ditches, to be kept in order and to do the work intended that they should do, require each year very near the amount of labor expended in their construction to keep them in proper condition. Freezes, water or vegetation are at all times obstructing them, deepening or widening. They are in the way of plowing and hauling and take up a considerable area of the best land. They carry off plant food and organic matter convertible into plant food. As a whole open ditches are very undesirable and should never be tolerated except when circumstances require them.

UNDERDRAINS OR COVERED DITCHES.

The advantages and profits resulting from underdrainage have so many thousand times been demonstrated by practice, not only in the United States but throughout the civilized world, that all reading agriculturists and horticulturists have some information on the subject, if not of a practical kind; and that the use of tile is the most approved method of underdrainage is a fact long since established. In south Arkansas the cost of transportation added to the cost of tile sufficient for the drainage of one acre is often more than the value of the land, not taking into account the expense of putting down the tile. Before a farmer decides to underdrain his land he should consider the value of the land, the cost of draining it and the value of the increased crop yield resulting from the proper execution of the work; but not the crop yield of one year, but for as many years as the drains will probably be in good condition, which is indefinite when tile is used and may be from ten to twenty years with other material.

There is but little demand in south Arkansas for information on the subject of tile drainage and it is presumed that those who desire such information will get it either from some standard authority or from the manufacturers from whom the tile is purchased.

There are several substitutes for tile, one or more of which lie within the reach of every owner of land and may be procured at very little if any cost except hauling.

Stone drains.—On many farms stones are greatly in the way of the cultivation and growth of crops, and to rid the land of them is often a difficult problem. When they are of the right sort they make a drain almost as durable and effective as tile. The character of a stone drain will depend upon the size and shape of the stones at hand, and their use for the construction of underdrains not only gives a good and substantial drain, but the stones are gotten rid of incidentally. If the stones are irregular one row on each side may be set against the banks in the bottom of the ditch leaving the waterway between. Larger stones are then placed across the waterway, resting upon the two rows, thus leaving a culvert. The open spaces between these larger stones are then broken by smaller ones and the whole covered with straw, turf, grass, fine brush or such similar material as may be convenient. A few inches of loose earth is then thrown in, packed firmly, and then the remainder of the ditch filled to 2 or 3 inches higher than the adjacent soil that the ditch when settled will have its top not lower than the surrounding surface. If flat stones are convenient they may be used in three ways. A V shaped excavation may be made in the bottom of the ditch with a flat stone on either side and another covering the two, or one may be placed in the bottom with the base of two others resting on it and against the banks and leaned against each other at their upper ends, or one stone may be placed vertically against one bank with another resting one end against the other bank and the other end against the top of the first stone.

Stone drains are all made more serviceable if the bottom of the waterway is paved with flat stones, or even with plank, which act more perfectly than stones, but do not of course last so long. If, however, the drain has a flow of water sufficiently constant to keep the plank saturated, they may be counted on to last ten or fifteen years, or even longer.

Pole drains.—Very serviceable and quickly constructed drains may be made of ordinary poles with diameter of from 3 to 6 inches. Two poles are placed in the bottom of the ditch, one against each bank leaving a waterway between. The waterway should be less than two-thirds the diameter of the two bottom poles. The third pole, which is larger, is placed over the waterway and resting on the first two. Ordinary fence rails may be used as a substitute for poles, but poles are better, particularly if the bark has been removed. The pole drain should be covered with trash, etc., as are the stone drains.

Plank drains.—A V shaped trough, made of 6 inch plank of any desired length, inverted and placed in the drain is inexpensive, particularly in south Arkansas where lumber is cheap, and make drains both serviceable and durable. Each section of the trough should overlap the next section below about 6 inches. Low grade cypress lumber is very durable and can usually be had at reasonable prices.

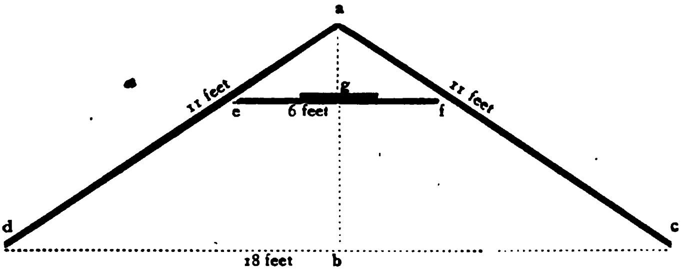
Brick drains.—Where brick or bats can be secured in sufficient numbers and at low cost they may be used for the construction of a drain about as serviceable and durable as tile, provided the waterway is also paved with brick.

In the construction of underdrains when the above materials are used too much care cannot be given to so constructing them that sand and fine soil will not wash down through the crevices between the material used and fill or obstruct the waterway. To avoid this each crevice should be securely covered with straw, stone, brush, bark, bagasse, or some such material, and this material covered with loose earth and firmly packed before the drain is finally filled. The wooden material mentioned cannot be expected to endure but a few years if it is alternately wet and dry, but when constantly wet it is almost imperishable.

No underdrain should be less than 3 feet deep if good results are expected. On the other hand it is rarely advisable to have them deeper than 4 feet, and the size of the watercourse is determined by the quantity of water that is to flow through them.

APPENDIX.

A good home-made terracing instrument may be made of two pieces of timber 11 feet long, and one piece 6 feet long. A convenient size for the strips is 2 inches square, but anything handy may be used provided it is strong and not too heavy to be handily moved.



The two large pieces are so fitted together at one end (*a*) that the other ends (*c* and *d*) are eighteen feet apart. The shorter piece is then fastened with its two ends (*e* and *f*) equidistant from the juncture (*a*) of the two longer pieces, and with its central point 2 feet from *a* and 4 feet from the center of the line connecting *c* and *d*. An ordinary mechanics' spirit level is placed at the center (*g*) of the short strip (*e f*). The ends of the longer pieces should be cut off at *d* and *c* so that they will rest flat upon the level surface. The upper surface of the short strip should also be plane or level, to support a spirit level. Terrace lines are marked off with this instrument in the following manner:

One end (*d* or *c*) is placed at a point where the proposed terrace line is to run and the other end moved up hill or down hill (as the case may be) until the spirit level (*g*) becomes *leveled*, as is indicated by its air bubble. Stakes are then driven in the ground where both ends (*d* and *c*) rest. One end of the instrument is then swung around until the instrument is in a reversed position and leveled again, when another stake is driven down at the forward end of the instrument. Thus the instrument is "walked" along the terrace line and releveled at each 18-foot "step" that it takes. It may not be necessary to put down stakes as often as the instrument is moved, but they can be put at intervals of 36, 54 or 72 feet, depending upon the regularity of the land surface.

The level and rod used by the Southern Branch Station was purchased of W. and L. E. Gurley, Troy, N. Y., and are catalogued at $30. Less expensive instruments are made by the same firm. Grade Level Company, Jackson, Mich., make three grades of levels ranging from $25 to $10 including target and rod.

C. L. NEWMAN.

Insects Injurious to Fruits and Vegetables and Remedies for Destroying Them.

The purpose in issuing this bulletin is to give in a condensed and popular form some information of the common insects that damage fruits and vegetables in the State. The information contained herein is taken from standard works on economic entomology, and is arranged as nearly as possible in a manner to meet the practical needs of farmers and fruit growers of the State. Only the common injurious insects are discussed, but if an insect is discovered injuring vegetation and no mention of it is found in this bulletin, some idea for successfully combating it may be had from the division of the bulletin on insecticides; under that division a general discussion of remedies is made with reference to the nature and habits of insects. In order to arrive at the best results in fighting insect pests and to know at what stage in its development to attack it, the life history of the insect must be understood.

In discussing each insect a brief description and life history is given and the remedies as far as known are given somewhat in detail.

Insects have four stages of development. First, the egg; second, the larva; third, the pupa or chrysalis stage; and fourth, the imago or perfect insect.

The Egg. The eggs are usually deposited on or near the food for the larvæ. They generally hatch soon after being laid, but with some insects they remain unhatched during the winter. In this case they are deposited where they are secure during the winter months, and are generally securely glued to some tree or shrub.

The Larva. Distinct names are given to the young or larvæ of different insects. The larvæ of butterflies and moths are called caterpillars. Those of beetles are called grubs, and when they live in trees they are called borers. The most common name applied to the larval form is worms. The larval stage is the growing period of the insect's development, and the one when the most harm is done by it. This stage may last from a few days to several weeks, and even months.

The Pupa. This is the chrysalis stage. When the larva has completed its growth it either spins a cocoon, or goes down into the ground and forms a cell, or in some other manner protects itself when changing from a larva to a complete insect. It remains in this condition with some insects only a few days, while with others the winters are spent in this stage.

The Imago. The perfect insect (beetles, moths, butterflies, etc.), is the final stage in the insect's development. The insect grows no more after reaching it, and the remaining work is to support life until it deposits its eggs for another brood. The length of life in this stage varies as in the preceding ones, it may be for only a few days, which is often the case, and it may be for months. With some insects, the winter is passed in this stage. They find some shelter in which they hibernate, and appear again in the spring, when the eggs are laid for the succeeding brood.

Thanks are due Professor H. Garman for the use of electrotypes for figures 13 and 14; Professor Gerald McCarthy figures 2 and 18, and to G. C. Bracket, Secretary Kansas Horticultural Society, for 1, 6, 7, 8, 9, 10, 11 and 12. Electrotypes for figures 3, 4, 5, 15, 16 and 17, were purchased from Professor C. V. Riley.

Codling Moth.

This most common of all apple insects is found in all sections of the country, and it does an incalculable amount of damage to the apple growers. As a usual thing, the greater portion of this fruit is injured by the worm of this moth. This moth appears in the spring about the time, or soon after the apple trees bloom, and the female lays her eggs in the fruit shortly after the blossoms fall. The eggs are generally laid in the blossom end. They hatch in about a week or ten days, when the worm enters the fruit and eats its way to the neighborhood of the core, where it continues feeding until it has finished its growth, which is probably in about thirty days after it enters the fruit. It then leaves the apple and finds some suitable shelter under which it spins its cocoon, in which it remains for about two weeks. The adult moth then appears to lay the eggs for the second brood. The eggs for this brood are laid on the side of the apple in place of at the blossom end. The larvæ of the second brood are the worms found in the fruit after it is gathered. Many of the worms leave the fruit before it is taken from the trees, and spin their cocoons in some suitable shelter, in which they live over winter. Others remain, and do not leave the fruit until after it has been gathered and stored away, when they spin their cocoons in the cracks of the barrels, or in protected places in the cellar.

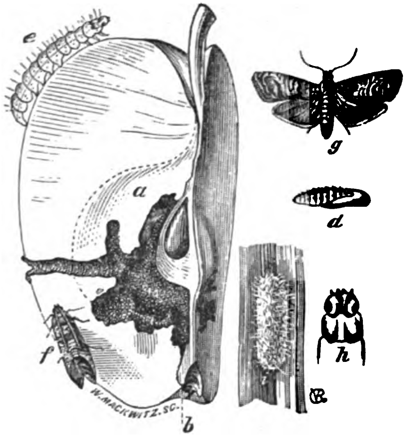


Fig. 1. The Codling Moth.

a, Burrow; *b*, point at which the worm entered; *e*, full grown worm; *d*, pupa; *f*, moth with folded wings; *g*, moth with expanded wings; *h*, head and first division of body of worm enlarged; *i*, cocoon which incloses pupa (Riley).

According to Professor Riley, "The worms remain in the larval state within their cocoons until towards spring, when they assume the pupa stage but a short time before appearing as moths."

The different stages are shown in the figure.

Remedies. There have been many remedies tried, but the one remedy that is universally conceded to be the best is spraying with the arsenites. Other methods are the placing of paper or rag bandages around the trunks of trees, in which the larvæ would spin their cocoons upon leaving the fruit. These bandages are removed every two weeks. The paper bandages should be burned, while the rags could be scalded and used again. This method does very well in the absence of a better one. Another plan is to allow hogs and sheep to run in the orchard and eat all the fallen fruit. This plan is a good one, for all the worms contained in the fallen fruit will be destroyed. Thus the second brood will be lessened. It is to be recommended when it can be done.

Spraying with Paris green or London purple, is the remedy now generally used. This is an inexpensive method for large orchards, and it can be successfully carried out for small orchards at a very slight expense. The first spraying should be given soon after the blossoms fall; the second, in about ten days, if the weather is fair; if rainy, in five or six days. The third may be given in about two weeks. The eggs being laid in the calyx end of the apple, it is essential that there be a supply of poison present, that when the worm hatches and commences feeding it will be killed.

If the greater portion of the first brood is destroyed, the danger from the attack of the second brood will be slight. It is advisable to spray with the arsenites in combination with a fungicide (Bordeaux mixture) where apple scab or or any of the fungous diseases do injury to the trees. This will be mentioned under insecticides.

Apple Tree Tent Caterpillar.

This insect is easily recognized from the figure, and an extended description of it will not be given here. The eggs are deposited during early summer. They are laid in clusters of rings around the small branches. These clusters consist of about two hundred eggs, perhaps more, which are covered with a glutinous mass that serves as a protection for them from the weather. In the figure, (*c*) shows the egg cluster from which the glutinous covering has been removed. As soon as the warm weather comes in the spring the eggs hatch, and the young caterpillars after eating of their gummy covering sufficient to give them strength, seek some fork or branch of the tree where they spin their web or tent. In this they remain when not feeding, and as they grow, the tent is enlarged. The caterpillars are voracious feeders, and do great damage to the trees attacked, especially where there are several tents in one tree. It is said that one caterpillar, when nearly grown, will eat two leaves a day. They do not go out of their tents to feed during damp, cold weather. In about five or six weeks they become full grown, when they measure about 1¾ inches in length. They then leave the trees and seek some secure place to hide during the chrysalis stage, which lasts about two or three weeks, when the adult comes forth to lay eggs for another brood.

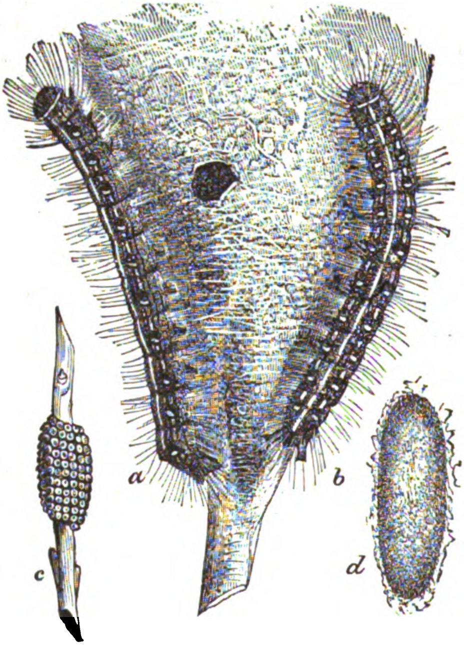


Fig. 2. The Tent Caterpillar.

a, Fully grown caterpillar; *c*, egg-mass on twig, with gummy coating removed; *d*, cocoon in which larva pupates. Natural size (Riley).

This insect is not as common in this State as some of the Eastern States; however, it is well that the remedies be known for it.

Remedies. Gathering the egg clusters is quite successfully practiced. They are very easily detected, and it is much easier to take them from the trees than it is the tent after the caterpillars have hatched. The trees should be carefully searched, and all egg clusters removed during the winter. If any of the egg clusters should be missed the tents or webs can be destroyed before the caterpillars have attained any size. The work is most easily done while the larvæ are young and should be attended to as soon as the webs or tents are discovered.

They probably do not leave their webs until after eight o'clock in the morning, and are in them again in the evening; also in damp, cool weather. It is important that the trees be carefully watched, and all tents destroyed, and also that the work be done while the caterpillars are in the tent.

The tents may be destroyed by applying a lighted torch to them. With a ladder they may be removed by hand. The best method is to cut off the limbs containing the tent and burn them.

Leaf Crumpler.

The clusters of withered and crumpled leaves which are the cases of this insect, are easily detected and readily recognized from the figure, in which (*b*) shows the cases as they appear attached to the limbs. The moth makes its appearance about the latter part of May or fore part of June. The eggs are laid on trees which will afford food for the worms. The worms are about one-third grown when winter sets in. They construct their places of abode, which are the cases seen in the figure. These cases are long and slender, figure (*a*). The silken threads that hold the withered leaves to the case also hold it securely to the limb of the tree. The larvæ pass the winter in these cases. They can be found in them at this time of the year (December), and are from one-fourth to one-third of an inch in length. Its length when full grown is about two-thirds of an inch.

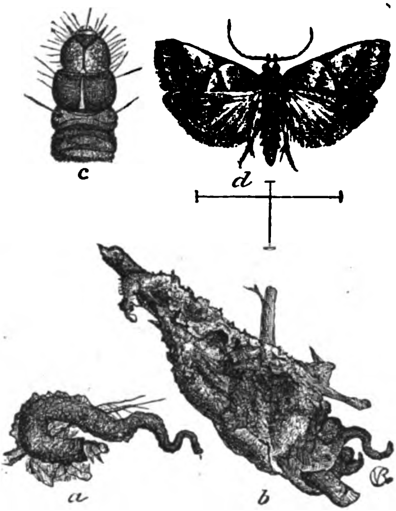


Fig 3. Leaf Crumpler.

a, Larval case; *b*, larval case with dead leaves; *c*, front part of larva; *d*, moth, magnified (Riley).

As soon as the warm weather of spring comes, and the buds expand, the crumpler resumes its activity, and commences feeding on the leaves and buds of the trees. This is when it does its greatest injury, the extent of which cannot be well estimated. Its growth is completed during May, when it goes into its chrysalis stage to appear during the last of the month or the first of the next as an adult moth. The damage from this insect in some localities is considerable, especially to young trees and nursery stock. In this locality it is found upon the apple and plum, and perhaps upon other trees. It is also said to attack cherry, quince and crab trees.

Remedies. Hand picking is the best remedy, as the insect has only one brood a year, and by picking these cases from the trees and destroying them, the increase can be checked. This method has been practiced in the Station orchard with good success. The work should be done in the winter.

Professor Riley says,* "Whether collected in winter or or pulled off the trees in spring or summer these cases should always be thrown into some small vessel and deposited in the center of the meadow or field, away from any fruit trees. Here the worms will wander about and soon die from exhaustion and want of food, while such parasites hereafter mentioned as are well developed in the pupa state, will mature and eventually fly off. In this manner we swell the ranks of our friends, while defeating our foes." The parasites mentioned are the larvæ of a small fly resembling the house fly, and a small ichneumon fly. It is evident that the above is a good suggestion, and can be followed without much additional labor.

Oyster Shell Bark Louse.

This insect is found doing damage in many sections in the Northern States. Its occurence in this State in all probability is limited to a few sections. We have had reports from two localities in the State where it is doing damage, and specimens of the bark from the apple trees attacked were sent with each report. It is not probable that it will spread to any alarming extent. However, a short description of it will be given to enable all to recognize it and take steps to destroy the pest as soon as discovered and prevent its spreading. Figure 4 represents the scales of this louse as they appear on the bark of the trees. The color of these scales is brown, with some portions yellow and gray.

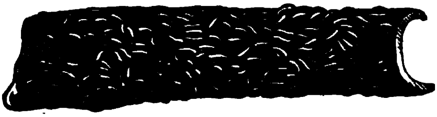


Fig. 4. Oyster Shell Bark Louse attached to the bark. Exact size (Riley).

---

* 4th An. Rep. Mo. State Entomologist.

They are about one-eighth of an inch in length. Their shape can be seen from the figure (7), which shows the under side. The bark is often entirely covered with them. The injury is considerable where a large portion of the tree is covered with the scales. Each scale contains from 20 to 100 eggs. These are white in color during the winter, but in the spring near hatching time they change to a yellowish cast, after which the eggs soon commence to hatch. Specimens of bark covered with these scales received at the Station May 7, showed both eggs and young larvæ under the scales. The young lice crawl over the trees for two or three days after hatching, then fix their beaks into the bark far enough to reach the sap and remain fastened to the tree for life. The young louse has the power of locomotion for only a few days, yet it is quite active, and may journey to adjoining trees, but it is not probable that it is spread in this way, as they are more liable to be blown by the wind, or carried on the feet of birds to adjoining trees. They are probably introduced into foreign sections by nursery stock. Figure 5 represents the egg and the louse at different stages of its growth, all highly magnified. (1) The egg; (2) the louse as it appears when first hatched, and before it becomes attached to the tree. The description of its growth after becoming fixed to the tree is as follows:

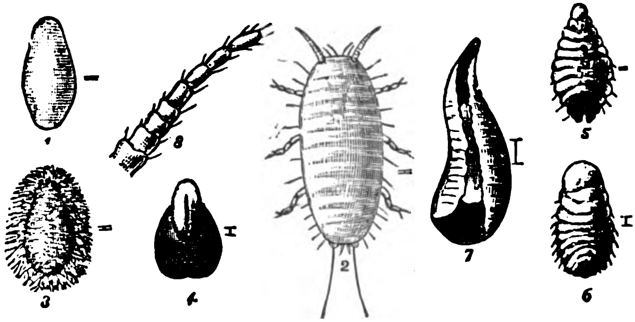


Fig. 5. Oyster Shell Bark Louse. (After Riley.)

"In a few days a fringe of delicate waxy threads issues from their bodies when they have the appearance shown at (3). Gradually the insect assumes the form shown at (4); (5 and 6) represent the louse when it approaches maturity and when detached from the scale.

Before the end of the season the louse has secreted for itself the scaly covering shown at (7), in which it lives and matures. The scale is figured as it appears from the under side when raised with the louse in it."

Soon after maturity the eggs are deposited for another brood. They hatch the following spring, as it is probable that there is but one brood in this section a year.

Remedies. During the winter and early spring the scales should be thoroughly scraped from the infested trees. While this is beneficial, and a greater portion of them are thus destroyed, all cannot be reached by scraping, and especially those on the smaller limbs. As the louse is quite easily destroyed while young when it is crawling over the trees and before it becomes fixed, it can be destroyed by applications of kerosene emulsion. The remedy should be applied at intervals during the time the lice are hatching and moving about over the trees. The proper time for application can be learned by keeping a close watch of the trees during the spring months.

A strong solution of soft soap and washing soda is also recommended to be applied during hatching time.

The Apple Root Louse.

This insect is quite common in this section of the State, and is found upon the roots and the branches of the apple tree. It is found upon the roots more generally, however,

---

(*) Saunders' Insects Injurious to Fruits.

and it is this root form of the insect that is one of the most serious pests to orchard growing in this section. On several occasions when trees have been examined that have had an unhealthy appearance the root louse was found on the roots in almost every case. The louse is shown in the figure (*b*). It is small and of a flesh color with a cover of a downy character, which is bluish white in appearance. This covering gives them the appearance of white mold when found on the roots, and aids greatly in detecting them. (1) "They are wingless during the summer, but during fall a few winged males and females are found among the wingless ones, and these lay eggs which remain over winter uninjured and hatch in the spring. They increase very rapidly during the summer, as they are produced alive by the females, by a sort of budding process, which admits of very rapid increase in numbers." Some of the lice probably remain alive over winter in the ground. The louse injures the roots by sucking the sap from them, and also by wounding them where it inserts its proboscis. These wounds are followed by swellings and deformities of the roots, which render them unable to perform their functions, and as a result the tree sickens and dies. Generally no signs of the pests can be detected when the roots of the dead trees are examined. (1) "While it usually confines itself to the roots of the trees, it is sometimes found on the suckers that spring up around them, and sometimes on the stump of an amputated branch, but in every instance it may be recognized by the bluish white cottony matter with which its body is covered. If this cottony covering be forcibly removed it will be found that in two or three days the insect will have again produced sufficient covering to envelop itself completely. Occasionally the mature lice crawl up the branches of the trees during the summer, where they also form colonies, and then are known as the wooly aphis of the apple."

---

(1) Saunders' Insects Injurious to Fruits.

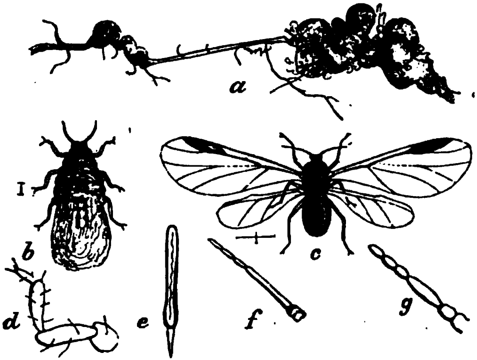


Fig. 6. Apple Root Louse.
a, An infested root; *b*, the larva; *c*, winged adult. All magnified (Riley).

Remedies. All nursery stock should be examined when received from the nursery, and if any signs of the pest are found, the roots of the trees should be treated before planting by putting them in hot water or kerosene emulsion. The latter is probably preferable. The water should be kept at a temperature ranging from 120 to 150 degrees Fahr. By this means it is possible to prevent the introduction of the lice into the orchard. Where trees have died from the effects of the louse, the lands should be cultivated in some other crop a year, and then some variety of fruit other than apples should be planted in the vacancies.

Destroying the lice on the roots of the large trees is a difficult task. Many remedies have been recommended and many more have been tried. Scalding water poured freely around the roots of the trees is recommended. The water should be very hot, and the soil removed from the roots to be at all effectual, and the water should be applied in large quantities so that all parts of the infected roots will be reached. This is impracticable where the roots of large trees are badly infested. Upon examination the louse is found 5 or 6 feet away from the trunk of the tree. It is very difficult to reach all the insects over so large a space. For small trees hot water would do very well. Water used for this purpose should be from 150 to 175 degrees Fahr. The soil should be replaced over the roots after the water is applied, but care is necessary in doing this that the replaced soil should contain none of the aphis. If it is infested, fresh soil should be used, so none of the insects will be returned. Mulching has been found to bring the lice near the surface, where they can be more easily reached by the water. Another remedy is carbon bisulphide. It is applied by making holes in the ground under the tree with an iron bar or a dibble, putting in an ounce of the liquid and covering up the hole as nearly air-tight as possible so that none of the fumes will escape.

Lime and ashes are also used to some extent. They are spread broadcast on the surface of the soil under the trees. All these remedies are on trial at the Station, and the results will be published when the tests are completed.

The best remedies are the preventative ones mentioned above. The trees should be dipped in hot water or kerosene emulsion before planting. While doing this the water should be kept at a certain temperature by having boiling water on hand to add to that in the vessel in which the trees are dipped.

If kerosene emulsion is used the roots should be kept in the mixture long enough for all parts of them to be reached. Another preventative is to dip the trees into a weak solution of lye which is said to kill the lice.

Round-headed Apple Tree Borer.

This insect is known over the greater portion of the country. It bores into the apple, pear, quince and similar trees. The adult beetle is easily recognized by two longitudinal stripes of white between those of brown on the back. The beetle flies only by night, and is not likely to be seen by the orchardist. It appears early in summer, and the female deposits her eggs in the bark of the tree near the ground.

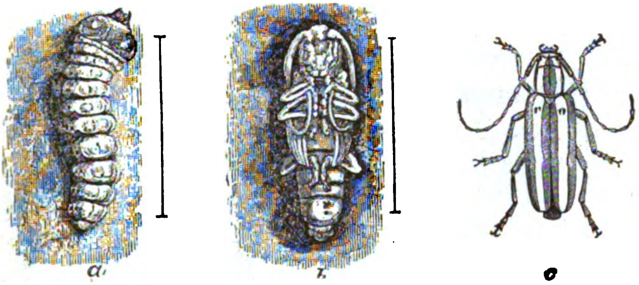


Fig. 7. Round-headed Apple Tree Borer.
a, Grub or borer; *b*, pupa; *c*, imago or adult. Nearly exact size (Riley).

(1) "The female makes an incision with her jaws in the part causing it to split open one-third to one-half inch in length, and thrusts the egg between the inner and outer bark, accompanying it with a gummy fluid, which covers and secures it in place. These hatch in a short time, and the small footless grub commences to eat its way into the bark. They usually remain in the tree as a grub for three years, during which time great damage is done to the trees infested."

(2) "The young lie for the first year in the sap wood and inner bark, excavating flat, shallow cavities which are filled with their sawdust-like castings. Their presence may be detected in young trees by the bark becoming dark colored, and sometimes dry and dead enough to crack, through which some of the sawdust-like castings often protrude and fall to the ground in a little heap. On the approach of win-

---

(1) Bulletin No. 3, Maryland Exp. Sta. (2) Saunders' Insects Injurious to Fruits.

ter the larva descends to the lower part of its burrow, and doubtless remains inactive until spring. During the second season it attains about one-half its growth, still living on the sap wood, where it does great damage and when, as often happens, there are several of these borers in a single tree they will sometimes cause its death by completely girdling it.''

During the next season it cuts into the solid wood and secures itself in a safe retreat, goes through the chrysalis stage, and appears the next spring as an adult beetle.

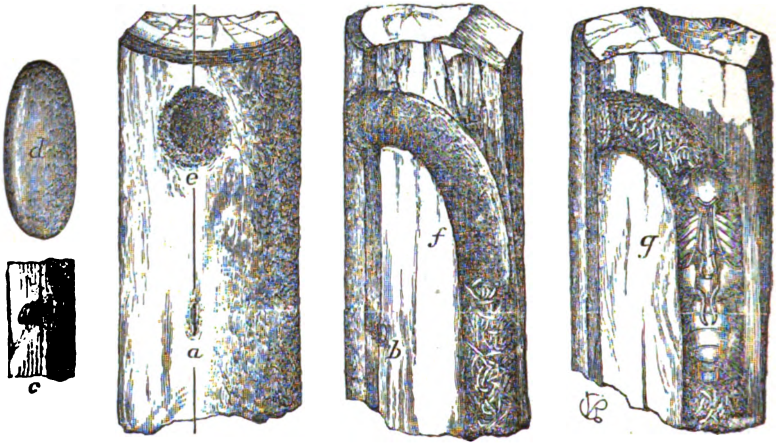


Fig. 8. Oviposition and Exit of the Round-headed Apple Tree Borer.

a, Wound where egg is deposited; *b*, same with the wood split lengthwise along the line (*a*, *e*), and turned so as to show an egg in place; *c*, same, with the bark split on the same line and removed to the left, so as to show the manner in which the egg is commonly thrust to one side under the bark; *d*, the egg, enlarged; *e*, hole of exit of beetle; *f*, the same, as it appears from the side when split along the line (*a*, *e*); *g*, the burrow, as it appears while the insect is in the pupa state, and before the bark is perforated (Riley).

Remedies. As is seen from the life history and the method of attack of this insect the best remedy must be preventive. Among these are the washes applied to the trunk of the trees that are so repulsive to the beetle that it will not lay its eggs on a tree protected by such washes. Soft soap reduced to the consistency of a thick paint by the addition of washing soda, is recommended by Saunders in ''Insects Injurious to Fruits.'' Carbolic acid solution is recommended by Professor Cook (1). Professor Riley says (2): "I generally take a bar of hard soap and rub it up and down the trunks of the young trees and place a piece in the principal crotch, allowing the rains to gradually wash it down over the trunks."

Carbolic acid should be used with moderation as it is liable to injure the foliage if applied too strongly.

In case the preventive measures have not been used, and the grub has entered the bark, it may be discovered by the discoloration of the bark and the castings on the ground, and it should be destroyed as soon as discovered. They can be dug out with a pocket knife, and where they have burrowed deep, they may be reached with a stout wire thrust into their holes.

Flat-headed Borers.

The beetle of this borer differs much from the round-headed one. It is of a greenish-black color, rather flat in shape and flies about in the daytime in place of at night. The female lays her eggs in the crevices of the bark of the tree during May or June. The larva that is soon hatched is quite different in appearance from that of the round-headed borer. It has a broad, flat head, with the body tapering toward the posterior end. It eats into the bark and feeds upon the sap wood during the summer where it excavates broad, flat channels. One grub sometimes completely girdles a tree. It does not confine its attacks to the base of the tree, but also affects the trunk. It completes its growth in one year. The damage from the borer is not confined to the apple, but it attacks the pear, plum and other trees.

---

(1) Bulletin 58, Mich. Exp. Sta. (2) Bulletin 23, Maryland Exp. Sta.

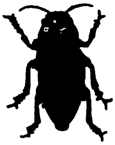


Fig. 9. Parent Beetle of Flat-headed Borer—nearly exact size (Riley).

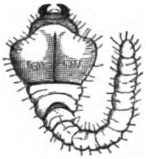


Fig. 10. Flat-headed Borer—nearly exact size (Riley).

(1) "While the round-headed borer is found in older trees, and frequently in trees that otherwise seem vigorous, yet it prefers trees of feeble growth, or those which are newly transplanted, and those growing upon ridge land, or in plowed orchards are more liable to attack than those growing in lowlands or orchards seeded to grass. With the flat-headed borer, however, a great predilection is shown for trees that have been injured in any way, and newly transplanted trees from a nursery should be particularly watched. The injury is most likely to take place on the southwest side, which is most subject to the so-called 'sun scald.' In fact, it is doubtful if the young larvæ or the eggs can withstand the strong flowing sap of a vigorous tree, and in almost every case in my experience where the borer has done damage it has been as a consequence of some prior injury." The remedies for this borer are the same as for the round-headed borer.

Peach Borer.

This, the most destructive insect to the peach, is well known to the peach growers of the State. The adult insect is shown in the figure. Female (1) and male (2). It usually appears in the spring soon after the leaves put forth. The female deposits her eggs on the bark of the tree near the surface of the ground. When hatched the larvæ work downward in the bark of the tree and roots. As it grows it devours the bark and sap wood of the tree and causes the exudation of gum which is readily noticed as a thick mass around the base of the tree. The castings are also pushed from the excavations. The borer, when full grown, measures over one-half inch in length. It resembles the round-headed apple borer in appearance, but is distinguished from it by having six scaly and ten fleshy legs. It goes through its transformations in one year, and the adult appears in early spring. In badly infested trees the bark is entirely consumed for an inch or two below the surface. The peach borer also attacks plum trees although it causes no exudation of gum as with the peach.

---

(1) Bulletin 23, Maryland Exp. Station.

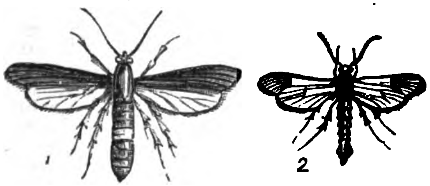


Fig. 11. Parent Moths of Peach Borer.
1, Female; 2, Male (Riley).

Remedies. When the borer is known to be present the best remedy is a knife and a stout wire. The trees should be carefully examined and wherever the exudation of gum is found the borer can be counted on as being present. The bark should be cut away, and the borer can be reached and killed with the wire. The trees should be gone over and examined at least once a year. Twice a year would be better, during both spring and fall. Hot water, or hot soapsuds is sometimes used to kill the borer; the earth should be removed from the tree, and a good quantity of the hot water used.

Mounding the trees is a remedy of which much has been written. Early in the spring the earth should be drawn to the base of the trees until a mound one foot high is made.

This should be tramped solid. This is said to prevent the grub from entering the bark, as it cannot enter the tough bark so high up the tree, and dies before reaching the tender bark and roots. This will also prevent the adult beetles that may be coming from the base of the trees from appearing. The mound should be removed after the moths disappear, which is probably about the middle of the summer. The use of washes to poison the grub as soon as hatched is also recommended.

Plum Curculio.

This is the most destructive pest to the plum grower, and is widely distributed over the country. The perfect insect is a beetle about one-fifth of an inch long, of a dark brown color, with a little red and gray interspersed. It has an elongated black hump on the middle of each wing case, behind which is a yellow band with white markings. The beetle is provided with a curved snout or beak projecting downward from the eyes, with the jaws at the extremity, (*c*) in figure. The female lays her eggs in the green fruit soon after it is formed. She performs the operation in the following manner: With her jaws, which are at the end of her snout, she cuts through the skin of the fruit and inserts the snout, making a cavity large enough to receive the egg which is placed in it. She then cuts a crescent shaped slit around the hole as shown at (*d*) in figure. This slit is

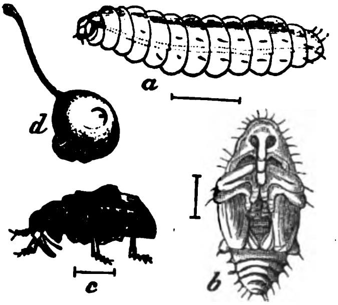


Fig. 12. Plum Curculio.

a, Larva; *b*, pupa; *c*, beetle, magnified, hair lines show exact size; *d*, plum, showing crescent mark (Riley).

rather deep, the object being to wilt the part around the egg, thus preventing the growing fruit from crushing it. The total number of eggs laid by each female is from fifty to one hundred. The egg is white, oblong-oval in form, and can be distinctly seen by the naked eye. The eggs hatch in three or four days in mild weather. In cold weather they remain a week, or even longer, before hatching. The young larva is a small footless grub which immediately begins to feed upon the flesh of the plum. It is full grown in from three to five weeks, by which time the infested and prematurely ripe fruit has fallen to the ground. The grub causes the fruit to secrete a kind of gum which escapes from the opening in which the egg was laid. The larvæ then leave the fruit and burrow into the ground, and go through the pupa stage, which lasts about six weeks. The insect is single brooded, the adults hibernating in sheltered places during the winter, and are ready to commence work as soon as the fruit is formed in the spring. The male, as well as the female, feeds upon the fruit of the plum, but the male does not make the crescent shaped mark. They also feed upon the buds and leaves of the tree, also upon cherries. The damage done peaches is almost as great as that done plums in some localities, and apples are also damaged to a considerable extent by being punctured by them.

Remedies. The remedy for the insect consists in destroying the beetle. The jarring method is recommended. The beetle is easily jarred from the trees, and will generally remain motionless for some minutes. It is owing to this peculiarity that they can be collected on sheets placed under the trees. The sheet should be large enough to catch all that fall. It may be attached to a light frame, which will make it convenient to carry from tree to tree. The beetles should be collected from the sheets and destroyed. The jarring is done by striking the tree with a heavy mallet, which should be padded in order to prevent injury to the tree. The time for jarring the trees is either very early in the morning or late in the evening. This is a sure method of getting rid of the insects if the work is vigorously kept up. The trees should be jarred every day, and the work continued as long as any insects can be caught.

Spraying with the arsenites has been extensively tried and varying successes reported. It has been shown conclusively that when properly done the damage from plum curculio may be greatly prevented by spraying. The value of this method is based on the fact that the insects feed on the foliage of the trees as well as the fruit. Either London purple or Paris green, 1 pound to 200 gallons of water, to which should be added a small amount of freshly slaked lime, is the formula used. The first spraying should be given before the blossoms open, the second soon after they fall, and the third in from six to ten days, according to the weather. Remarkably good results have followed spraying for the plum curculio in many sections of the country. Professor S. T. Maynard reports good results from three sprayings of Paris green combined with Bordeaux mixture (1). "On the sprayed trees the fruit was not injured by the curculio, but on unsprayed trees the fruit was entirely destroyed by them." Good results have also been obtained at the Ohio Experiment Station.

Three applications were made with the London purple at the Minnesota Experiment Station by Professor Green, who gives the following results: (2) "The results from these three applications of insecticides have been marked. The ripe fruit on the trees that were syringed was almost entirely free from blemishes. The plums were of unusually large size, well colored and of excellent flavor, as they had nothing to cause premature ripening. The fruit from the trees that were not treated with the insecticide contained scarcely a specimen but what was injured by the work of the curculio or gouger, besides, they ripened much earlier, and were of inferior flavor and size as compared with the fruit of trees that were syringed. The foliage of the syringed trees was uninjured."

Strawberry Leaf Roller.

This insect was reported at the meeting of the State Horticultural Society, at Van Buren, last summer, as doing considerable damage in some sections where strawberries are extensively grown.

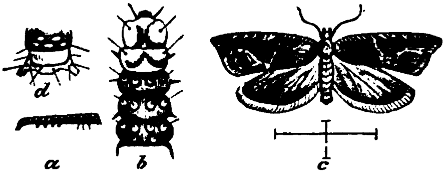


Fig. 13. The Strawberry Leaf Roller.

a, Larva, natural size; *b*, head end of larva, enlarged; *d*, hind end of larva, enlarged; *c*, moth, enlarged, the hair lines showing natural size (Riley).

---

(1) Bulletin 25, Hatch Exp. Sta. (2) Bulletin 10, Minnesota Exp. Sta.

Professor Garman says: (3) "The injury done by this leaf roller is all accomplished while it is in the caterpillar or larva stage. At this period of its existence it is a small faintly greenish worm, a trifle less than a half inch long. Soon after it hatches from the egg it begins to fold the leaves together, bringing the upper side of one-half of a leaflet in contact with the upper side of the other half, and fastening them so with bands of silk. In the retreat thus formed it spends its whole larval existence, feeding upon the leaf, and ultimately causing it to turn brown and shrivel up. When it has its growth as a larva it changes within the leaf to a brown quiescent pupa about one-fifth of an inch long. Finally it assumes the adult form, emerging as a small obscurely marked brown moth, with a wing expanse of about one-half an inch." According to Professor Garman, there are several annual broods in Kentucky. The grown larvæ are found the first week in June. The larvæ of the last brood are found in the leaves during the latter part of September and first part of October. They leave the leaves at the approach of cold weather.

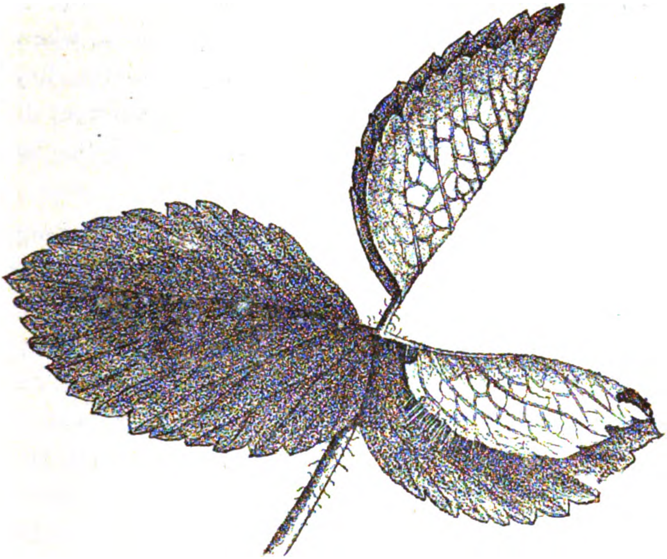


Fig. 14. Representing the work of the Strawberry Leaf Roller (Garman).

Remedies. Spraying with the arsenites has not given satisfactory results. Hand-picking would be out of the question where more than a garden patch is grown. The remedy given in Professor Garman's bulletin seems all that could be desired. (1) "The leaf roller can be almost exterminated in a field by mowing the plants while the larvæ or pupæ are in the leaves, allowing the mowed leaves to dry a short time, then burning over the bed, perhaps with the aid of a little straw or rubbish. This can be done without the slightest injury to the plants." The best time for burning in this State is probably during September or October.

The Strawberry Crown Borer.

The adult of this insect is a beetle about one-sixth of an inch in length, and of a chestnut brown color. It appears in the spring and deposits its eggs about the crown of the plants, and when hatched the grub tunnels into the crown and eats of the substance until it is full grown, when it is about one-fifth of an inch long. It changes into the chrysalis within the root of the plant, and the beetle emerges during late summer or early fall. It is single brooded, the beetles hibernating during winter.

---

(1) Bulletin 31, Kentucky Exp. Sta.

Professor Garman says: (1) "There is little danger of the borer getting among plants on new land at a distance from infested beds so long as the plants for new beds have not been obtained from infested ones." As the grubs and pupæ may be found in the crowns of the plants from the middle of June until September, it is evident that plants should not be taken from infested beds for planting during this period. Old beds should be plowed up and other crops grown for two or three years, by which method the pests can be practically exterminated. Spraying for this insect would not prove effectual.

Other Strawberry Insects.

The Smeared Dagger. The adult is a gray moth with a wing expanse of about two inches. The larva is a brightly colored caterpillar about one and one-half inch long. The body and head are black with the body ornamented with spots and four longitudinal bands of yellow. The early brood appears in spring and the second in fall. It injures the plants by feeding upon their leaves. It also feeds upon apple and peach, raspberry and several other plants. Spraying with Paris green or white hellebore may be used for the second brood. If quite abundant so that spring treatment is necessary pyrethrum may be used.

The Tarnished Plant Bug. This is a small bug, brown to black in color with yellowish markings. It injures the strawberry by puncturing the green fruit, causing it to develop irregularly and shrivel up when severely attacked. Besides being particularly destructive to the strawberry, being an active feeder, it attacks the young leaves of the pear, grape, currant and other plants. (1) "It not only injures plants by puncturing and abstracting the sap, but the wounds produced by its beak are followed by an extensive blackening of the surrounding parts, perhaps due to some fluid ejected by the bug at the time of making the puncture, an effect very different from that caused by the punctures of other bugs."

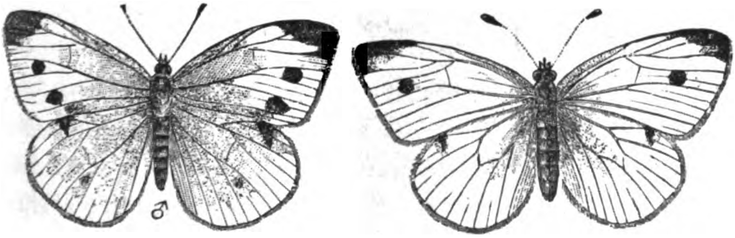
---

(1) Bulletin 31, Kentucky Exp. Sta.

Remedies. Pyrethrum powder may be used. The powder may be dusted upon the strawberry plants as mentioned under insecticides. Damp weather reduces its numbers considerably.

Cabbage Worms.

Imported Cabbage Worm. All who grow cabbage are probably acquainted with this insect. The adult butterfly is the common white one that is seen hovering over cabbage fields during the summer. It is ordinarily white with dark markings as seen in Figure 15. Occasionally one is found of a light yellowish color. The female lays her eggs on the under side of the leaves. They hatch in about a week. The larva is a little green caterpillar about one-fourth of an inch long, but when grown measures about an inch to an inch and



Male. Female.

Fig. 15. Imported Cabbage Worm Butterfly (Riley).

---

(1) Bulletin 31, Kentucky Exp. Sta.

a quarter in length. The color of the worm is nearly the same as cabbage. It begins to eat on the under side of the leaf. It eats through the leaves, and devours a good portion of them, working toward the heart of the cabbage, where it finds its tenderest food. After becoming full grown it leaves the plant and goes through the chrysalis stage to emerge in a few days as a perfect butterfly. There are several broods each year. This is one of the serious pests to the cabbage growers, and does great damage to the crop where no effort is made to destroy the worms. It may be easily controlled by using the proper insecticides.

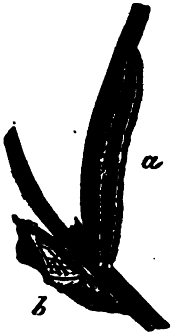


Fig. 16. Imported Cabbage Worm.
a, Larva; *b*, chrysalis (Riley).

Remedies. The best remedy is pyrethrum powder. It may be used either in dry or wet mixture. We have used it both ways, but prefer the wet mixture, as it is much easier to apply and the work can be done more rapidly. When applied in this way it should be done with a spray pump. When applied dry it may either be sifted on the plants or what is better, applied with a hand bellows, which will distribute the poison to all parts of the plants, and between the leaves, thus reaching all the worms.

Cabbage Plusia. The adult insect is a dark gray moth with light colored markings, a small white spot and a V shaped mark can be seen near the middle of the fore wings from the figure. The moth usually flies at night, but is sometimes seen about the plants on cloudy days. The eggs are laid in clusters on leaves. The caterpillar is pale green in color, marked with light longitudinal stripes. It measures about two inches in length when full grown.

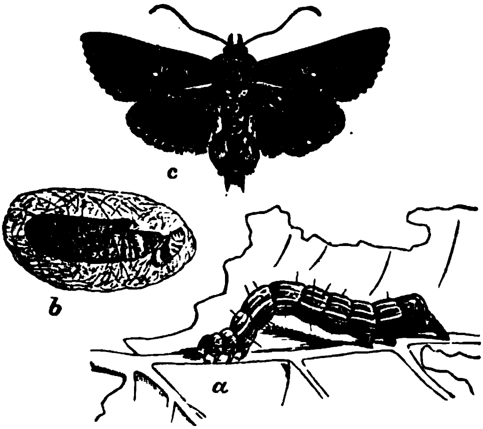


Fig. 17. Cabbage Plusia.
a, Larva; *b*, chrysalis in cocoon; *c*, moth (Riley).

Remedies. Same as for imported cabbage worm.

Other Cabbage Worms. There are several other worms that do damage to cabbage, some or all of which, may be found in this State, but as they do damage in the same manner, and may be destroyed by the same remedies as those mentioned, they will not be described.

The Harlequin Cabbage Bug.

This is the most serious of all cabbage pests that cabbage growers have to deal with in this section of the country. The color of the insect is black with red and yellow markings on the wings, the under surface of the bug being white and yellow. The pupa differs from the mature bug only in being smaller and without wings. The larva is quite small, and has more yellow on its body than the older insects. The eggs and different stages of the insect are plainly shown in the figure.

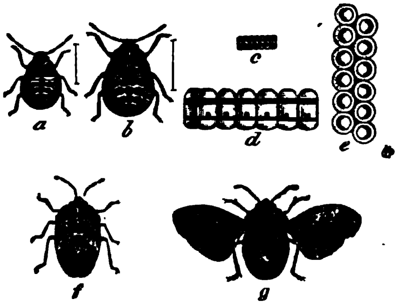


Fig. 18. Harlequin Cabbage Bug.
a, b, Young; *c, d, e,* eggs; *f, g,* adult, natural size (Riley).

(1) "The adult bugs hibernate under old grass, stones, logs and other rubbish, and upon the advent of spring take the first cruciferous plants that put forth leaf, and lay their little barrel shaped eggs in small clusters on the under sides of the leaves. There are several generations in the course of the summer, and wherever the insect becomes abundant the crop is generally ruined. The insect feeds upon the cabbage in all stages of growth; not by gnawing the leaves, but by puncturing them with its beak, causing the leaves to wilt by exhaustion of the juices."

Remedies. We have tried several remedies on our cabbage grounds at the Station, but all have failed entirely with the exception of kerosene emulsion, which was only a partial success. The emulsion may be successfully used while the bugs are quite young, however, but is not effectual on older ones. The best remedy known is the one recommended by Professor Weed, who says (2): "There is but one efficient remedy for this insect, which is to destroy the brood that lives over winter when they congregate upon the mustard and radish plants. Here they can be destroyed very easily by the application of kerosene by means of a common water bucket or sprinkler." If the insects are thus destroyed early in the season it will wholly prevent injury later. The mustard or radishes should be planted in the cabbage field. The bugs will congregate on these plants, and may be killed by applying kerosene as before mentioned. The bugs will not injure the cabbage as long as there are mustard or radish tops for them to eat.

---

(1) Bulletin No. 23, Maryland Agri. Exp. Sta. (2) Bulletin 21, Mississippi Exp. Sta.

Cut Worms.

There are several species of cut worms, but their life histories are so near alike that the general life history will be given, which will answer for all. The moths usually appear in late summer. They are the moths that frequently enter houses at night where they are attracted by the light. The eggs are deposited near plants, the tender roots of which will afford food for the young larva, which is usually about one-third grown when winter sets in. It then descends deeper in the ground and remains in a torpid state until spring, on the approach of which it comes to the surface and attacks a great variety of plants. Nearly all garden vegetables are attacked by them.

Remedies. Clean culture is a good preventative from cut worm attacks. When setting out plants the stems may be wrapped in stiff brown paper, the upper edge extending two inches above the surface, the lower edge below. This method may prove useful for garden work, but could not be considered practical for field work. One of the best methods to kill the worms is given by Professor Gerald Mc-

Carthy. (1) "The best preventative of cut worms is to spray Paris green upon green succulent vegetation of any kind, especially clover and cabbage leaves, dust upon these some wheat flour, and roll the leaves in a ball and tie. Prepare the field at least a week before planting, and distribute the poison balls throughout the field, say 10 feet apart, the worms coming to the surface and finding no growing plants will eat the poisoned baits. The baits must be renewed when withered. A shingle may be placed upon each ball to keep it moist."

The Colorado Potato Beetle.

The native home of this beetle is in Western Colorado. It is said that its original food was a species of wild potato, indigenous to the Rocky Mountain region. Since cultivated potatoes have become a general crop, it has spread to nearly all sections of the country and is the worst foe to the potato crop. The adult beetle is nearly one-half of an inch long. It is of a yellow color with dark longitudinal stripes on the wing cases. The eggs are usually deposited on the under side of the leaf in clusters. They hatch in about a week. The small larva is of a reddish color with a few black spots along the sides of the body. The larva eats continually and is a great feeder. In a few weeks when it becomes full grown it descends into the ground and goes through the pupa stage, coming forth in about ten days when the eggs are laid by the adult for another brood. There are several broods each season. The adult beetle lives over winter and deposits the eggs for the first brood early in the spring. They feed upon other plants besides the potato, but the greatest damage is to that crop.

Remedies. The use of the arsenites as an insecticide was first practiced for destroying this beetle. Either London purple or Paris green may be used. They may either be applied dry with flour, wood ashes or land plaster, or in suspension in water. When used dry 1 pound of the arsenites to about 50 pounds of flour or ashes, or 100 pounds of land plaster is recommended. When applied with water, from 4 to 6 ounces of the arsenites to 50 gallons of water with the addition of a pint of molasses or a quart of flour paste to make the poison adhere, is recommended. It may be used stronger, but when so used the addition of the syrup or flour is not advised. The applications should be commenced as soon as the insects appear and continued as often as necessary to keep them in check.

---

(1) Bulletin 84 North Carolina Exp. Sta.

Beneficial Insects.

Insects are not all injurious or useless. They are of great assistance in the perfect fertilization of many of our fruits and plants. The value of the Honey Bee for this purpose is recognized by fruit growers, and bee keeping is encouraged by them. There are also other classes that are of benefit—the predaceous and parasitic insects. They are of great assistance in the warfare against the pests and should be protected and encouraged. Among the predaceous class may be mentioned the Lady Bugs. They are small reddish colored beetles nearly circular in shape. Their wing cases are dotted with spots of black but never stripes. Some are black in color. There are many others that are useful. There are parasites that prey upon many of the insects mentioned in the bulletin and all help to keep our foes in check.

As it is important that we recognize our friends as well as our foes it is expected to put cuts of beneficial insects in a future bulletin.

Insecticides.

Insecticides are divided into two classes to correspond to the two methods of obtaining food practiced by insects. Those for eating insects will not answer for the sucking class. Those classed as eating or biting are those that are provided with an upper and a lower lip and strong jaws moving sideways between the lips, thus enabling them to chew the foliage and fruit, cut the stems of plants and bore into the bark and roots of trees and other plants. This masticating class comprises the greater portion of our fruit and vegetable insects and it may be divided into two divisions—borers, which are difficult to reach because of their burying themselves into the roots, stems and wood; gnawers, which are easily reached by external applications of poisons.

The other class of insects are those that obtain their food through a long beak-like organ by sucking the juices of the plant or tree. This organ is inserted through the bark or skin with very little injury to the surface. It is useless, therefore to attempt to poison their food. The only method of killing them is to apply some substance that will arrest breathing by coming in contact with their bodies or by collecting and crushing, or otherwise destroying them.

The most practical method of destroying the biting insects is to poison their food by applying some substance on the surface of the plant attacked so that when obtaining food some of the poison will be eaten. This class comprises a large portion of our fruit insects as is seen from the description of the individual insects. It is an important item in the successful fruit grower's work to be able to destroy them. The arsenites have come into general use as an insecticide for this class of insects.

Arsenites. The use of arsenites becoming general, as it has, for insecticidal purposes has caused alarm from some owing to the supposed danger of arsenic poisoning from eating sprayed fruit and vegetables. These fears are for the most part groundless, and the main danger is from having the material on the farm in bulk. Care should be exercised that all such poisons be kept out of reach of children or animals. It is seen at a glance that the use of arsenical poisons upon the cabbage plant is attended with danger, though if properly applied it may be used with perfect safety, but its use is not recommended for that plant. For spraying fruits there is no danger. In the first place the spraying is not done near the time of ripening of the fruit, and, secondly, there can be no danger from the poison collecting and remaining on the fruit. In all probability all the poison has left the surface of the fruit within two weeks after being applied.

When fruit trees are treated for both fungus diseases and insect attacks it is best to apply the arsenites in combination with the fungicide (Bordeaux mixture), as they can be applied as easily in combination as otherwise; thus saving one-half in labor.

When the arsenites are used in combination with Bordeax mixture it is not necessary to add lime as when applied alone; as the lime in the Bordeaux mixture prevents injury to the foliage from the arsenites.

Methods of Applying Insecticides.

Spraying. This method of applying insecticides and fungicides is the most practical of any. It is the cheapest, and by far the best. When spraying, it is very essential that the work be well done. A fine mist-like spray is more likely to reach all parts of the tree than a coarse one, and it also distributes the poison more evenly. Spraying for biting insects should be commenced early, and the poison kept on the surface of the plants attacked until all danger is passed. Spraying machinery may be obtained at a reasonable price from the companies making a specialty of that class of goods. For garden work and low plants the knapsack sprayer, or hand sprayer is generally used. The knapsack pump is better, but the other is cheaper, and does very well unless a large amount of spraying is to be done. For orchard work a spray pump attached to a barrel or tank is generally used.

Care must be taken not to spray before the blossoms fall. The importance of this cannot be too strongly urged, as it is destructive to insects so important to the thorough fertilizing of the flowers and it does not prove so effectual, as the poison is liable to be washed off before it is needed. Furthermore it is highly injurious to bee keepers in the vicinity by destroying the bees.

Dry Mixture Applied. A very simple way to apply is to enclose the poison in a muslin bag, attach a stick to it, and shake it over the plants; another method is to take a tin can or box, with the bottom perforated or covered with a seive, to which attach a handle. In dusting the poison on plants, it is always best to be careful and walk on the windward side of the plant to avoid breathing any poison. One of the best ways of applying the dry mixture is by using a small hand bellows, that is manufactured expressly for the purpose.

Paris Green.

This poison is an arsenite of copper, and usually contains about 58 per cent of arsenic. The amount varies, as it is subject to some adulteration. It is only slightly soluble in water, which makes it superior to other forms of arsenic as an insecticide, as it is the soluble arsenic that is injurious to foliage. Paris green first came into use as an insecticide for the Colorado potato bug. It is now in general use as an insecticide for biting insects, and is reported as being destructive to scale insects, and plant lice as well. Paris green is very heavy, and must be constantly stirred when in suspension in water for spraying. The strength generally recommended is 1 pound to 200 gallons of water. It can be used on some foliage stronger. On apple trees it may safely be used 1 pound to 160 gallons of water. There is less danger to foliage when a fine spray is used and the work is also more effectual. In preparing for use, the poison should be first mixed with a little water in a small vessel, and a thin paste made so that all parts will be dampened before being added to the water.

Paris green can also be applied dry, one part of poison to twelve parts of flour to some plants; for others the amount of flour should be much more—that is on foliage liable to be injured. It is also used with land plaster or sifted wood ashes. Wood ashes can be used very advantageously for this purpose. They may be collected during the winter, and should be kept perfectly dry. The operation of mixing the poison with the other ingredients is very important. Much depends upon the thoroughness with which this is done.

London Purple.

This insecticide is an arsenite of lime. It is a residue obtained in the manufacture of analine dyes. It does not contain as much arsenic as Paris green, but its efficacy in the destruction of insects appears to be about the same, and it only costs about half as much per pound. It is more soluble than Paris green, therefore more caution should be exercised in spraying with it owing to its liability to injure the foliage. It is used in the same proportions as Paris green. It has been found that freshly slaked lime added to the arsenite and water will lessen the injury to the foliage. Just the amount to use varies, probably one pound fresh lime to every pound of Paris green or London purple. This poison may be applied either in dry mixture or with water. As to the relative value of London purple and Paris green as insecticides, there seems to be some question. There are reports of careful work which show that Paris green gives better results than London purple, but since the addition of lime prevents plant injury, London purple can be as safely used. It is much cheaper than Paris green, and is easier to apply, as it remains in suspension much more readily.

Pyrethrum.

This insecticide is the powdered flowers of a certain species of herbaceous plants known as pyrethrum. Other names for this powder are Persian Insect Powder, Insect Powder, and Dalmation Insect Powder. This insecticide kills by contact, and not by being eaten. It is not poisonous except to insects, therefore can be safely used under all circumstances without the least fear that it will be injurious to man.

As it loses its strength quite readily when exposed to the air, it should be kept in air-tight vessels and only fresh powder should be purchased. When applied dry, if fresh and pure, it is best to mix it with flour or sifted wood ashes. It should be allowed to stand a day or so in a closed vessel after being mixed, to get the best results. It may then be dusted on the plants, or applied with a hand bellows. It is sometimes used for freeing rooms of house-flies. This is done by blowing some of the powder about the room with a hand bellows, which so stupefies them that they fall to the floor when they should be swept up and burned. When used for this purpose, it is not mixed with other ingredients. For farm insects it gives good results to apply with water. It should be applied with a fine spray. One table-spoonful of the powder to two gallons of water is the strength generally used. The fumes of burning pyrethrum are also injurious to mosquitoes and flies.

Arsenate of Lead.

This insecticide was first proposed by Mr. T. C. Moulton, of the Gypsy Moth Comm., Malden, Mass., and Professor C. H. Fernald devotes some space to it under the head of a new insecticide in *Bulletin No. 24, a brief summary of which is here given. It is prepared by putting 11 ounces of acetate of lead and 4 ounces of arsenate of soda into a hogshead containing 150 gallons of water. These substances quickly dissolve and arsenate of lead is formed. It is a fine white powder which readily remains in suspension in water. To aid the poison in adhering to the leaves two quarts of molasses are added. It remains on the tree for a long time even after quite heavy rains.

If the mixture should be used three or four times stronger than given above no evil effects result. It can be used much stronger than necessary and no damage is done to the foliage. It is light and therefore remains in suspension readily. As a result it can be evenly distributed. For the Colorado Potato Beetle three-fourths pound to 150 gallons of water proved satisfactory at the Hatch Experiment Station.

From the above, arsenate of lead bids fair to become a valuable insecticide for biting insects, and should future testing verify the results already obtained it may come into general use. The cost of the chemicals is given at 8 cents per pound for arsenate of soda and 14 cents for acetate of lead, at wholesale, which makes it a cheap insecticide. The substances are both poisonous.

---

*Hatch Expt. Station of Mass. Agr'l College.

White Hellebore.

This is a vegetable poison. It can either be used dry, as a powder, or with water. When used dry it may be used with four or five times its bulk of flour, and applied with a hand bellows or sifted and dusted over the plants. When used with water one heaping table-spoon of the poison to two gallons of water. This insecticide not only kills the insects by contact, but also when eaten. It is used for the currant worm, rose slug and insects that infest gooseberries. As with pyrethrum, this powder should be kept in air-tight vessels as it loses its strength on exposure.

Kerosene.

Kerosene is very destructive to insect life. It is probably owing to the rapidity with which it spreads over the insects and closes the breathing pores. It is a cheap insecticide, and where it can be used without injury to vegetation it is one of the best for sucking insects. It is not safe to use it in the pure state on plants.

Riley-Hubbard Formula—Kerosene Emulsion.

Kerosene	2 Gallons.
Common soap or whale oil soap	½ Pound.
Water	1 Gallon.

(1) "This insecticide acts by contact, and is applicable to all nonmasticating insects (sucking insects, such as true bugs, and especially plant lice and scale insects) and also to many of the mandibulate or masticating insects, such as the apple worm or plum curculio, when the use of arsenites is not advisable. Kerosene emulsion may be made by means of various emulsifying agents, but the most satisfactory substances—and those most available to the average

---

(1) Farmers' Bulletin 7, U. S. Dep. Agri.

farmer and fruit grower—are milk and soap suds. In each of these cases the amount of emulsifying agent should be one-half the quantity of kerosene. One of the most satisfactory formulas is that given above. Heat the solution of soap and add it boiling hot to the kerosene. Churn the mixture by means of a force pump and spray nozzle for five or ten minutes. The emulsion, if perfect, forms a cream which thickens upon cooling, and should adhere without oiliness to the surface of glass. If the water is hard, or has a large percentage of lime, add a little lye or bicarbonate of soda, or else use rain-water. For use against scale insects dilute one part of the emulsion with nine parts water. For most other insects dilute one part of the emulsion with fifteen parts of water. For soft insects, like plant lice, the dilution may be carried to from twenty to twenty-five parts water. The milk emulsion is produced by the same method as the above."

Professor Cook's Formula.

Soft soap	1 quart.
Water	2 quarts.
Kerosene Oil	1 pint.

(2) *How Prepared.* "One quart of soft soap or one-fourth pound of hard soap to 2 quarts of boiling water. As soon as the soap is well dissolved, stir in while it is yet hot, 1 pint of kerosene oil. This is violently stirred until it is permanently mixed. The stirring is best done with a force pump, arranged to pump the liquid back into the same vessel. It should be so well mixed, that when left standing, the oil will not separate. When ready to use add enough water to make 15 pints in all—that is, one-fifteenth of the liquid is kerosene oil."

---

(2) Bulletin 58, Michigan Exp. Sta.

Carbolic Acid Wash.

Hard Soap	1 pound.
Water	2 gallons.
Crude carbolic acid	1 pint.

The soap is dissolved in the boiling water when the carbolic acid is added. This wash is used against scale and bark lice on trees, and may be applied with a stiff brush. When applied to prevent borers from depositing their eggs it may be put on with a cloth, and should be applied early in summer, and again later, probably in July. The trunks of the trees and lower limbs should be covered, but care taken that none be applied to the foliage.

Tobacco Decoction.

Tobacco	1 pound.
Water	2 gallons.

This decoction is a good fertilizer for plants, besides being an effective insecticide for insects that injure indoor plants. It is also said to be useful in ridding outdoor plants of the flea beetle and other insects of that class. It is often used on domestic animals to rid them of lice. It is prepared by boiling the stems or refuse tobacco in water, after which the liquid is strained and applied with a spray.

Bisulphide of Carbon.

This is a very valuable insecticide for certain insects. It is a clear liquid and is heavier than water. It volatilizes easily, and the vapors are very disagreeable. It is owing to the rapidity with which they are given off that it is valuable as an insecticide. It is used for underground and grain insects. It first came into use in France, where it was used to destroy the grape phylloxera, an insect that does damage to the roots of the vine. It is used quite extensively to rid stored grain of insects. The fumes being heavier than air, sink through the entire mass of grain, and kill all the insects present.

Care must be exercised in handling it, as it is very explosive when mixed with the air, and inflammable when brought near the fire.

Spraying Apparatus. The following firms make a specialty of supplying spraying apparatus, descriptive circulars and price list of which may be obtained by writing them:

The Deming Company, Salem, Ohio.
P. C. Lewis Manufacturing Company, Catskill, N. Y.
William Stahl, Quincy, Ill.
Field Force Pump Company, Lockport, N. Y.
Nixon Force Pump and Nozzle Company, Dayton, Ohio.
Gould Manufacturing Company, Seneca Falls, N. Y.
W. and B. Douglas, Middletown, Conn.
Leggett & Brother, 301 Pearl st., New York, N. Y.
Thomas Woodason, Philadelphia, Pa.

The two last named firms furnish machines for applying dry mixtures.

When insects not mentioned in this bulletin are found doing damage in the State we will be pleased to receive specimens and any information regarding the damage done by them. When sending insects inclose in a tight box with some of the plant upon which they are found feeding and send by mail. Any inquiries regarding insects found doing damage to our fruit crops will be cheerfully answered.

JOHN T. STINSON,
Horticulturist.

TABLE OF CONTENTS.

PAGE.

Introduction 55
The Codling Moth 57
Apple Tree Tent Caterpillar 59
Leaf Crumpler 61
Oyster Shell Bark Louse 63
Apple Root Louse 65
Round-headed Apple Tree Borer 69
Flat-headed Apple Tree Borer 71
Peach Borer 72
Plum Curculio 74
Strawberry Leaf Roller 77
Strawberry Crown Borer 79
Other Strawberry Pests 80
Imported Cabbage Worm 81
Cabbage Plusia 82
Harlequin Cabbage Bug 83
Cut Worms 85
The Colorado Potato Beetle 86
Insecticides 88
Arsenites 88
Spraying 89
Mixtures Applied Dry 90
Paris Green 90
London Purple 91
Pyrethrum 92
Arsenate of Lead 93
White Hellebore 94
Kerosene Emulsion 94
Carbolic Acid Wash 96
Tobacco Decoction 96
Bisulphide of Carbon 96
Spraying Apparatus 97

Kitchen Garden.

The economic importance of the kitchen garden is but slightly appreciated in Arkansas, and as a consequence it is given but careless attention. It is no difficult matter to curtail the table expenses one-fourth by giving a garden of less than one acre the care and attention it deserves. Favored as we are with soil and climatic conditions, fresh vegetables of a large variety can daily be gathered from a well kept garden nine months of every year, frequently ten months, and occasionally throughout the entire year. On the other hand, conducted as the gardening operations are, the results neither afford profit nor pleasure. A very large majority of the residences throughout Arkansas have an enclosure near at hand that is called "the garden." As the spring approaches last year's growth of weeds is piled and burned, the surface of the soil is stirred (rarely deeper than three or four inches), and potatoes, peas, corn, beans and squash are planted and tomatoes transplanted. When these vegetables are in danger of being crowded out by weeds and grasses they are partially cultivated. As the time for them to fruit comes around, cultivation ceases, grasses and weeds take possession and hold undisputed sway until the following spring, unless a portion of them are plowed up and turnips broadcasted for early spring "greens." As a natural consequence of this practice only vegetables inferior both in quality and quantity are produced; discouragement follows and the garden is abandoned. This is no pen picture of the imagination, but the record of observations made not in and about Camden alone, but in various localities of several Southern States. It is true, however, that there is an occasional well kept garden yielding in variety and abundance through the greater part of the year. While many persons are lavish in their praise of such a garden, it rarely occurs to them that they might read the object lesson and follow the example.

It is an easy matter to grow a good garden if the proper attention is given it and at the proper time. The best soil for a garden is a deep, light, thoroughly drained sandy loam well filled with humus or decayed vegetable matter. Deep and light sandy soils are common in Arkansas. If the drainage and humus are wanting they should be supplied.

The success of all subsequent operations in gardening depends upon the preparation of the soil. Unless stiff, unpliable clay is near the surface plowing cannot well be too deep in land of even moderate fertility. If a soil is originally but 5 inches deep and by plowing and incorporating manure it is made 10 inches, its quantity is doubled and its producing capacity doubled. A garden soil should be at least 10 inches deep and thoroughly pulverized throughout. A soil in a poor physical condition may contain fertilizing materials in quantities sufficient for the production of a good crop, but only a very small part of these materials can be converted into vegetable growth until the soil becomes friable. A soil that is the most friable and mellow, and possesses the greatest capillary porosity has the greatest capacity for holding fertilizing materials, and in proportion to the degree it is pulverized will it resist the effects of leaching and drouth.

Plowing and harrowing should be continued until there is no doubt but that the soil is in its proper physical condition, even should it be necessary to repeat both plowing and harrowing many times. Success depends upon the proper preparation of the soil. It is too often the case that the preparation is not begun until the time for planting, and then the haste in getting the seed in is greater than the care of preparation.

The application of manure in quantities sufficient to give the best results is of rare occurrence. One hundred pounds of cotton seed meal or a few wagon loads of stable manure is oftener more than the yearly ration for a garden than it is less. It is not uncommon for market gardeners in the vicinity of cities to yearly apply *25 tons of stable manure to one acre of land, and 50 and 75 tons per acre have paid a large per cent on the investment.* These heavy applications of stable manure are often supplemented with several hundred or even a thousand pounds of commercial fertilizers and a profit of several hundred dollars result from the products of one acre. The profitable application of these large quantities of manure is referred to for the purpose of illustrating the fact that it is quite difficult to fertilize too heavy if the application is wisely made. A poor soil, however, cannot be fertilized excessively without injury resulting in some way to the growing crop, unless the material used has been well fermented, thoroughly incorporated with the soil and is not too concentrated As a rule the more fertile the soil the greater is the quantity of manure that can be applied without injury. Whether applied broadcast or in the drill it is better that the fertilizer be applied a few weeks before the seed are planted. If applied broadcast it should be put down before the preparation of the soil begins that it may be more equally distributed and thoroughly incorporated. If in the drill the same rule holds good. Having properly manured and prepared the soil and planted the seed with regard to its capacity, the next thing demanding the attention of the gardener is cultivation.

The object of cultivation is not merely to suppress the growth of grasses and weeds, but also, and at all times, to keep the earth mellow and loose. During the early growth of plants the soil cannot be stirred too often if the roots are not molested. When the plants have attained size the cultivation should be continued, but care exercised that it be sufficiently shallow to avoid too great injury by cutting roots. Soil may be cultivated when too wet, and often is, but never when too dry, if the cultivation is shallow, as nearly all cultivation should be. Each rain should be followed by a thorough scarification of the soil's surface. This not only kills the young weeds and grasses before they have damaged the crop, but loosens the soil that air may be admitted and moisture retained. Even with proper preparation and judicious manuring the success or failure of a crop may still depend upon its treatment during dry weather—deep cultivation might ruin or shallow might save. A loose soil covering intercepts the moisture arising from below, thus performing the office of a mulch; increases the deposit of dew; gives freer admission to rain and air, and facilitates chemical action.

No weeds or grasses should at any time be allowed to mature seed. If this is carefully attended to there will be in two or three years quite a diminution of these pests.

Rotation should be systematically practiced in every garden, not merely for the purpose of the soil's recuperation, but to lessen the effect of insects and fungus attacks.

The various vegetables cultivated in gardens occupy the soil different lengths of time, making it possible to produce half-a-dozen or more crops on the same plot of soil within the space of twelve months. As illustrative of this intensive rotation the following schedule gives the different crops grown on this Branch Station in 1894 on a plot of ground 45x10 feet.

(1) Radishes were planted in the early spring in rows 2 feet apart. Later (2) lettuce was transplanted into rows marked off between the radishes. The radishes came off in six weeks and their rows prepared and planted in (3) snap beans. Every other row of lettuce was planted in (4) corn when the lettuce was cut. The beans were followed by (5) lettuce, and the corn and lettuce by (6) onions and (7) radishes. The onions now occupy the plot. This rapid rotation will sometimes have a tendency to decrease the ravages of both fungi and insects, if care is exercised to use only such plants as are not of close botanical relation, and the plants attacked destroyed before the insect or fungus attacking them have reached the degree of development necessary to propagation.

When any vegetable ceases to fruit, or there is no further use for it, the plants should at once be removed, if any way diseased, and destroyed. The plot should be at once prepared, manured and in a few weeks planted again. No garden plot should remain idle. If there is no particular use to which it can be put, nothing is better than to plant in cowpeas if in the spring or summer and in rye or some other hardy grain if in the fall or winter. If the rye is turned under green it will add greatly to the fertility and physical properties of the soil. No matter how rapidly one crop follows another, the soil should be manured before each planting of seed, provided fermented and well decomposed manures are used. Unfermented manures, and particularly animal products, often act disastrously to growing crops. No manure is better than well decomposed stable manure, and the results from its use are often better the second than the first year. Its bulk materially affects the physical properties of the soil, and the *quality* of vegetables is affected more by the physical condition of the soil in which they are grown than by its fertility.

The financial importance of the kitchen or private garden is rarely appreciated. Such a garden, even when properly cared for, may not *bring in one cent*, but it is hard to estimate the *dollars it keeps* in the family purse. Its importance should be estimated from the amount *saved* and not the amount *made*; and aside from the economy, pleasure and commendable pride that the owner derives from a well kept garden, he has the satisfaction of knowing that he is providing his family with fresh and wholesome food, lessening his doctor's bill and very probably prolonging the lives of those depending upon him.

The experiments reported in the succeeding pages were made to determine some reliable information for gardeners. The varieties of the several plants were carefully selected for their reported merits and from a personal knowledge of many of them. Plants do not succeed alike under different circumstances—soil, climate, fertilization, season and other things affecting their profitable culture—but pure and sound seed are essential to success under any circumstance. Inferior and unsuitable seed often prejudice one against gardening. The surest way to secure the best seed is to purchase directly of seedsmen known to be reliable and handling varieties and classes known to succeed in the soil, climate, etc., in which the seed are to be grown (*See appendix*).

The soil upon which the plants reported in this bulletin were all grown on poor sandy upland, and in the majority of instances the manure and fertilizers were applied in very small quantities. In fact, the soil was inferior in fertility to the average upland of similar character in this portion of the State. In the average season and with the culture generally given cotton, four acres would barely produce more than 500 pounds of lint without the aid of fertilizers.

The Effect of Fertilizers Upon the Germination and Earliness of Garden Peas.

a. Effect upon Germination.

The soil used for this experiment was light sandy, poor, and had not for two years previous been fertilized at all, and very little had ever been given it. The fertilizers were distributed in well opened furrows and thoroughly incorporated with the soil. They were covered with two furrows, and the narrow bed thus made raked to nearly a level before the peas were planted. One hundred apparently sound peas were planted over each fertilizer. The table gives the average of two plantings, one made the first and the other the last week in April. Four hundred pounds each of the fertilizers were used per acre.

VARIETIES OF PEAS.	PER C'T. GERMINATED.			
	400 pounds Kainit.	400 pounds Nitrate of Soda.	400 pounds Acid Phosphate.	400 pounds Cotton Seed Meal.
Alaska*	9	6	23	4
Bishop's Dwarf Long Pod	86	72	98	53
Carter's Strategem	74	42	96	76
Dwarf Blue Imperial	85	34	91	73
Dwarf Sugar	70	85	96	68
Extra Early, or First and Best	69	92	100	98
McClean's Little Gem	69	71	88	42
Average	66	57	85	59
Average, Alaska excluded	75	66	95	68

*The Alaska peas failed to germinate at all in the second planting, and the figures represent only the per cent germinating from the first.

(*b*) *Effect upon Earliness.*

This experiment was not at first planned, but in making a record of the per cent of peas germinating from the fertilized plots it was noticed that all the varieties fertilized with acid phosphate were up three or four days before the same varieties fertilized with the other materials. The second planting of peas was planned and executed for the purpose of verifying the first, but the results varied but little and in the majority of cases none at all. The two plantings are reduced to an average.

A good rain fell in less than twenty-four hours after each planting and the conditions were very favorable both for germination and growth. The table represents the average of two plantings of six varieties.

	Kainit.	Nitrate Soda.	Acid Phospate.	Cotton Seed Meal.
First appearance above ground	4	3	1	4
First Blossom	4½	4	1	6
First Ripe Pods	8	6	1	9

The acid phosphate plots were the earliest in every instance, and the figures in the other columns represent the appearance above ground, the blossoms or the ripe pods, as the case may be, in days later than the acid phosphate plots. The kainit and cotton seed meal plots were four days later than the acid phosphate plots, and the nitrate of soda three days later in appearing above ground.

The greatest difference in time of blossoming recorded was with the Dwarf Sugar variety—the first blossoms appearing on the cotton seed meal plot *nine days later* than on the acid phosphate plots.

Later in the season the experiment was repeated on more fertile soil. Only the Dwarf Blue Imperial was used, but the difference in the time of germination, blossoming, and ripening from the effects of the fertilizers, was slight and irregular, except where acid phosphate was used, and this fertilizer advanced the peas less than two days. This slight difference as compared with the earlier plantings, may have been due to the lateness of the season, but more probably to the increased fertility of the soil, there already being present more nearly the requisite quantity of phosphoric acid. But that acid phosphate has—and independent of the increase in yield resulting from its use—a tendency to *hasten* the growth and maturity of many plants is an established fact. As the highest prices are often paid for the earliest vegetables the market gardener and truck farmer might by a liberal and judicious use of acid phosphate get his goods on the market a few days earlier.

Cabbage.

During the year 1894 four plantings of cabbage seed were made. The first planting was March 1 and transplanted April 7; the second March 30 and transplanted April 19; the third July 4 and transplanted August 18; the fourth October 5 and transplanted December 22. None of the plants were in any way protected from cold. The plants from the plantings of July 4 and October 5 required almost daily watering while they were yet in the plant bed, and were completely shaded from the midday sun. As the young plants approached a size sufficiently large for them to be transplanted the shading was removed late in the afternoon and early in the morning returned, keeping it on during the heat of the day. The length of time the midday shading was allowed to remain was gradually decreased until a week before the plants were transplanted, when it was left off entirely. The plants thus became gradually accustomed to the hot sun. Shading is necessary to have plants for the fall crop.

The plants transplanted December 22 were frozen continuously for forty-eight hours, on December 28 and 29, the minimum temperature of both of these dates being 8° F. above zero, and only a small per cent of the plants were killed. The remainder of the same lot of plants had not been removed from the plant bed and were nearly all killed. Five hundred plants were lifted early in December and set thick in unfertilized soil to harden and make stocky and with the hope that they might pass through the winter uninjured and furnish plants for early spring transplanting. They had begun growing when the temperature was at 8° and about all were killed. It is very probable that the survival of the plants transplanted December 22 is due to the fact of their being in a partially wilted condition—not having recovered from the operation of transplanting—and the cells not being full of sap there was sufficient room for expansion, in the process of freezing, to prevent rupturing the cells.

A portion of the plants transplanted August 18 were harvested between December 18 and December 25, before attaining their full growth and not one head was injured by cold, notwithstanding that the minimum temperature during November and December, prior to December 25, was below freezing (32° F.), on twenty-one different days, and below 26° F. on four different days. About 20 per cent of the remaining portion of the August 18 transplanting survived the 8 degree temperature, and only a few plants passed through it without injury.

The following table gives the results of the three successive transplantings of several varieties. In each case plants of uniform size were used. Those of the second transplanting however, were very small. They were transplanted early to hasten maturity, and occupied soil more fertile than that into which the other plantings were put, and rotted badly in June just as the heads were beginning to form.

NAMES OF THE VARIETIES OF CABBAGE.	Average Weight.	Seed Planted March 1. Transplanted April 7.		Seed Planted March 30. Transplanted April 19.		Seed Planted July 4. Transplanted August 18.	
		Per cent heading.	Average Weight pounds.	Per cent heading.	Average Weight pounds.	Per cent heading.	Average Weight pounds.
Crescent City L'ge Late Flat D'ch	2¾	90	3⅛	75	2 1/16	100	2⅛
Drumhead Savoy	1 3/10	40	15/16	10	11/16	50	2¼
Early Dwarf Savoy	½	60	¾	....	....	50	⅞
Early Flat Dutch	1¾	100	2 7/16	90	1⅛	100	1½
Early Jersey Wakefield	1¾	100	2 3/16	95	1¼	100	1½
Early Large York	1½	95	1¼	40	13/16	20	2¼
Early Winningstadt	1½	80	2¼	65	1 1/16	60	1 6/16
Frotscher's Superior Large Late Flat Dutch	3¼	95	4 1/16	55	2 11/16	100	3 1/16
Green Globe Savoy	⅗	30	9/16	10	½	10	¾
*Harvest Home	3½	....	....	85	3 1/16	90	4⅛
Improved Early Summer	3	100	3	65	2 7/16	70	3 7/16
Improved Large Late Drumhead	2⅛	....	....	....	....	60	2⅛
Large Flat Brunswick	3⅕	100	3⅛	70	3	100	3½
Solid South	1¾	100	2¼	85	1 15/16	90	2 9/16
Stein's Early Flat Dutch	2½	95	3 1/16	80	1½	90	2 3/10
Average	2	83½	2⅗	59	1½	72⅔	2 3/10

* The seed of the variety "Harvest Home" were sent out by Northrup, Braslan, Godwin & Co. The others were purchased of Richard Fortscher.

These three crops of cabbage were grown on poor upland with very moderate applications of commercial fertilizers, stable manure and cotton seed meal, the last two being put down a few months before the cabbage occupied the ground. When the first heads begun to form, a top-dressing of acid phosphate, nitrate of soda and kainit (or muriate of potash) was cultivated into the soil, the top-dressing being repeated two or three weeks later. When the soil was being made ready for the plants it was plowed deep and close, harrowed repeatedly and brought into as good physical condition as possible. While the plants were small they were given two plowings, first with a bull tongue and then with heel sweep. Later the cultivation was with the hoe or rake, and the surface at all times kept loose by stirring after each rain as soon as the soil was sufficiently dry.

The cabbage caterpillars at times appeared in large numbers, but were destroyed with a solution of tobacco sprayed over the plants. This not only killed the caterpillars but after the second application prevented the flies from laying more eggs. A plot but a short distance from those treated was not sprayed until two weeks later, by which time the cabbage were almost destroyed by the caterpillars, which, though small, were in large numbers; as many as eighty-four being counted on one plant measuring only 15 inches across. Those succeeding best were, in the order named:

FOR EARLY HEADS.	FOR LATER HEADS.
Stein's Early Flat Dutch,	Harvest Home,
Early Flat Dutch,	Large Flat Brunswick,
Early Jersey Wakefield.	Frotscher's Late Flat Dutch.
	Crescent City Late Flat Dutch,
	Improved Early Summer.

A Few Remarks on Growing Cabbage.

The local interest taken in the fall and winter cabbage grown on the Southern Branch Station, and the lack of information concerning the growth, culture, etc., of the cabbage indicated by the questions asked, makes it very probable that a few suggestions on the subject will be appropriate.

Several things are necessary to produce good cabbage that are frequently neglected or overlooked by the novice and the amateur. The most important of these essentials are:

First. Good seed of a good strain and an appropriate variety.

Second. A rich, deep soil well manured and thoroughly prepared.

Third. Frequent and thorough cultivation, but not deep after the first two or three weeks.

Fourth. The young plants well watered and shaded if grown for fall or early winter transplanting.

To attain a degree of excellence in the cultivation of any plant it is necessary that the seed be fresh, reliable and of a variety suited both to the soil and season of the year, as well as to the purposes for which they are to be grown. Many cultivators of private gardens purchase their seed of local merchants who sell on commission. Such seeds are often the most expensive a person can plant. Each planter of seeds should order directly from some seedsman known to be reliable and handling such varieties as are known to succeed best in the locality in which the purchaser resides.

Soil cannot be made too rich for cabbage, nor can the best cabbage be grown on poor soil. If animal or any fermenting manures are to be used they should either be applied several months before the soil is to be occupied by cabbage or well composted before put down. "Green" manure, or manures that have not undergone the changes incident to fermentation, have a more or less tendency to cause cabbage to rot. The best soil for cabbage is a rich, deep sandy loam, and should be well drained either naturally or artificially. Before transplanting begins the soil should be thoroughly prepared 8 or 10 inches deep, and 12 or 15 would be better. Thorough preparation cannot be too much insisted upon, and frequent and shallow cultivation is absolutely necessary. By cultivation it is not merely meant that no grass and weeds should grow with the cabbage, but that the soil's surface should at all times be in a loose, pulvarent condition. All cultivated plants should, as a rule, be worked as soon after each rain as the soil is dry enough to be stirred without injury.

The cabbage and other plants of the same family (cauliflower, turnip, radish, mustard, etc.) should not occupy the same soil two seasons in succession, nor should one member follow another of the same family. Plants of the same order, and oftener of the same genus, are more or less subject to the attacks of the same parasitic fungi and insects, and if closely related plants are repeatedly grown on the same soil these enemies will increase and often to so great an extent as to destroy the crop. Systematic rotation should be practiced in every vegetable garden. Its almost total neglect is the cause of many failures.

Seed for the spring crop of cabbage should be sown in November, December and January in hotbeds or cold frames, that the plants may be ready to transplant in February and March. For the fall crop the seed must be sown in June or before the middle of July. The seed bed planted in the summer must never be allowed to become dry and must be shaded from the hot sun. Leafy brush, boards or cloth may be used to furnish the shade and should be placed 4 feet above the surface of the plant bed. This admits of free circulation of air and gives the plants the benefit of the early morning and late afternoon sun. The plants grown for the spring crop in hotbeds or cold frames should be gradually accustomed to cold before transplanted, and the late crop gradually accustomed to the sun. Shadow trays 12 or 15 inches wide by 20 or 30 long, and 2 or 3 inches deep filled with good soil are very convenient and serviceable for propagating the plants either in the winter or summer. They can be placed in the shade when the weather becomes hot, or, in the absence of hotbeds and cold frames may be brought into the dwelling when the weather is cold. Many tender plants, such as tomatoes, eggplants, lettuce, cucumbers, etc., may be treated in like manner and had ready for permanent transplantation into the open ground as early as the seed could be safely planted without this or similar precautions.

The degree of cold that cabbage and other biennial plants can endure without injury is far lower than many persons suppose. This degree of cold, however, depends upon accompanying conditions. If the cold is preceded by a warm period, which produces a quick succulent growth, a temperature of 25° F. may prove fatal; on the other hand, if the cold increases gradually, the plants become enured to it and have many times endured a temperature as low as zero. In January, 1894, about 99 per cent of 1,000 plants were killed by *fourteen* degrees of cold following unusually warm weather for that month, while 8 degrees occuring two days in succession last December killed less than 5 per cent of a plot of cabbage just transplanted, killed not less than 95 per cent of a lot transplanted three weeks before and drawn from the same plant bed, and about 60 per cent of a lot transplanted in August. These plots contained 150, 500 and 200 plants, respectively. Spinach, lettuce, salsify, onions, and some turnips survived this 8 degree cold, while radishes, carrots, parsnips, cauliflowers, beets and winter vetch were killed. The lot of cabbage of which 95 per cent were killed, had begun growing after recovering from the check occasioned by transplanting, and had very nearly doubled their size. Their new growth made them more susceptible to the cold.

In south Arkansas the temperature rarely is so low as 20° F. before December 25, and cabbage transplanted in July will have ample time to produce good heads before that date, and can either be marketed at once or kept until later, at the discretion of the producer.

The young plants should never be allowed to grow too thick in the plant bed, but given room to make a strong, stocky growth. There is no better way of securing this growth than by transplanting, when the third or fourth leaf appears, to another bed or tray and set from 1 to 2 inches apart. This secures good strong plants with an abundance of roots. In transplanting cabbage the plants should invariably be set in the ground up to the bud, no matter how long the plants may be. Water should be liberally used in the summer transplantings. When it becomes necessary to put the plants out in dry weather, I find it a good plan to open good large holes for the reception of the plant and fill them with water. When this water soaks into the soil fill the hole half full again and put the plant in, leaving only dry soil around the plants on the surface of the soil. Cabbage rows should be from 3 to 4 feet apart and the plants from 18 to

36 inches in the row, the distance depending upon the variety of cabbage and the fertility of the soil.

Fall Crop of Irish Potatoes.

Extensive experiments with Irish potatoes planted for fall crop were undertaken, but a complete failure in every particular was the result. Weekly plantings of unsprouted potatoes were made from the middle of July until the 1st of September. Three different efforts to sprout them before planting failed completely, and the fourth was barely 10 per cent of a success, and nearly all these died when planted, from either drouth or excessive heat. Although the seed potatoes were from three or four different sources and embracing three varieties, they invariably rotted, whether planted whole or cut, deep or shallow. These failures are directly attributable to the excessive heat and repeated drouths of the year 1894 (See Meteorological Summary p). The crop of 1893 reported in bulletin No. 28 was a success, and in other localities of the State the 1894 fall crop was a success.

Lettuce.

After March 1 there was not a day during the remainder of the year that lettuce was not growing in the Station garden. With the exception of July, August and September and the last four days of December, it was at all times of excellent quality and good size, notwithstanding some exceptionally dry and hot periods when shading and watering the young plants was necessary. The severe cold of the last week in December killed all the larger plants, but about 200 which had been transplanted in December survived and now promise to do well. The young plants were always transplanted once and occasionally twice. In hot weather it was necessary to induce germination, that the seeds be placed between folded strips of cloth, moistened and placed in a cool place. The sprouted seeds were planted and until nearly large enough to transplant the young plants were shaded by either boards or cloth. The soil into which the lettuce was transplanted had some time previously been fertilized with stable manure and cotton seed meal. The plants were watered in with water into which a pound each of acid phosphate, muriate of potash and nitrate of soda had been dissolved to every 15 or 20 gallons. When the largest plants were of nearly a marketable size the above fertilizers were scattered between the rows and cultivated into the soil. The rows were from 12 to 18 inches apart and the plants 6 or 8 inches in the rows. The following varieties were planted and most of them several times:

Brown Dutch (Frotscher). Seed of this variety from the same lot were planted five times and not one germinated.

California All-Heart (Wood). An excellent variety, making a pointed, firm head, very tender and crisp, with an unusually sweet and rich flavor.

California Cream Butter (Wood). This ranks with the preceding but is not curled, and formed less perfect heads.

Denver Market (Wood and Department of Agriculture). Makes a rapid growth, but failed to head in any of the six trials made during the year. Flavor inferior to that of several other varieties.

Drumhead Cabbage (Frotscher). Succeed well only in early spring, but was then inferior to other varieties.

Early Cabbage or White Butter (Frotscher). One of the best and earliest varieties tested, forming solid heads, crisp, tender, sweet and delicate in flavor. One head with all loose leaves removed measured 3 inches in diameter, while the whole plant was 14 inches across. This variety averaged best throughout the year.

Grand Rapids (Wood and Department of Agriculture). An excellent variety, forming loose but very crisp heads. Stands drouth well and is very ornamental in appearance.

Iceberg (Burpee). Was not planted until late in the season and made but little growth.

New Giant White Cos (Burpee). A large and rapid growing variety, but formed no head. Flavor too strong.

New Orleans Passion (Frotscher). Plants measured 18 inches across with solid heads 3½ inches in diameter. Not so crisp and sweet as the Grand Rapids or Early Cabbage and does not grow so rapidly as other varieties. An excellent variety for fall, winter and spring, but fared poorly in hot weather.

Wheeler's Tom Thumb (Burpee). A small slow growing variety possessing slight merit.

Wood's Cabbage (Wood). Resembles the New Orleans Passion, but inferior in size and quality.

Pepper.

The varieties of pepper given below were planted in the open ground April 9, and when of sufficient size transplanted to rows 3 feet wide and the plants set 2 feet in the drill. The plots were fertilized broadcast with stable manure and in the drill with acid phosphate, nitrate of soda and kainit.

Bell or Bull Nose (Frotscher). An oblong variety of medium size and not prolific.

Golden Dawn or *Mango Sweet* (Frotscher). A very superior variety. The plants perfected from fifteen to thirty fruits of a clear, bright, golden yellow. Sweet and very mild.

Mammoth Golden Queen (Wood). Equal, if not superior to the preceding in good qualities. One fruit measured 9 inches long by 10½ in circumference. The plants averaged eighteen fruits. Sweet and mild.

Long Red Cayenne (Wood). A very hot variety and good for drying. Fruit conical and from 3 to 5 inches long; 158 ripened fruits were gathered from one plant.

Procopp's Giant (Wood). A large sweet pepper, the fruits measuring 8 inches long by 8½ in circumference. Very regular in size and shape with ten or fifteen fruits to the plant.

Red Cluster (Frotscher). A small hot variety with very ornamental plants; 213 fruits were counted on one plant.

Sweet Spanish or *Monstrous* (Frotscher). Very similar to Procopp's Giant, but the fruit does not taper to so sharp a point and the plants are more prolific.

Sweet peppers are eaten sliced with pepper and vinegar like tomatoes; sliced with fresh meats as a relish; as a salad, or they are stuffed as mangoes.

Eggplant.

This vegetable is not of as frequent occurrence in Southern gardens as it should be. It is a botanical relative of the tomato and should be given the same treatment, but does not require to be supported by stakes or frames.

Early Dwarf Oval (Frotscher). Three weeks earlier than the New York Purple. Fruit very small but the plants very prolific.

New Orleans Market (Frotscher). An oblong-oval, large and very prolific purple variety. The fruits are not so large as the New York Purple, but the plants are more prolific and continued longer in bearing and withstood drouth well. The largest fruit weighed 4½ pounds.

New York Improved Purple (Frotscher and Department of Agriculture) This is the most popular variety of eggplant and is cultivated throughout the United States, but in this year's tests of both early and late plantings it was inferior to the New Orleans except in size, the largest fruit weighing 5¼ pounds.

Cucumber.

Two plantings of cucumbers were made, one on April 12 and the other early in June. The second was practically a failure on account of drouth. The first named variety was planted only in April.

White Wonder (Burpee). A strong grower but not prolific. Fruit of regular shape and good size.

Early Frame (Frotscher). Early but continued in bearing but a short while. Fully half the fruits were imperfect.

Westfield's Chicago Pickling (Wood). Very prolific, medium early, but produced many imperfect fruits.

Improved Early White Spine (Frotscher). A prolific, early and very desirable variety, continuing well in bearing.

Long Green Turkey (Frotscher). Very large, medium prolific. Many specimens were hollow at the seed cavity. The largest full grown fruit measured 13 inches.

Thorburn's Everbearing (Wood). The most prolific and earliest variety tested. Continued in bearing for three weeks after all the other varieties had succumbed to drouth and produced marketable fruit eight days earlier than any one of the above varieties.

Squash.

Early Bush or Patty Pan (Frotscher). This variety is the most popular in the South. Its tough rind makes it valuable for shipping. Prolific, large, with cream colored flesh.

Fordhook (Burpee). Vines of rank growth, but fruit small. Can be used either green or for winter. Inferior to other varieties for green cooking and not so good as the cashaw or even the field pumpkin for winter.

White Pineapple (Plant Seed Co.). A little later than the Early Bush, but not so popular. The fruit very handsome in appearance and of good flavor.

Summer Crookneck (Frotscher). Withstood drouth better than the other varieties, continuing in fruit for a month longer. A little later than the early bush, but more prolific and superior for home use, but does not stand shipping so well.

Tomato.

The following varieties were planted in duplicate plots. The first was transplanted May 10, and the other late in June. A few plants of each variety were tied to stakes while the others were allowed to spread upon the ground. The staked plants were pruned throughout the season while the others were pruned until the first fruits approached maturity, when no further attention was given them. The plants tied to stakes ripened fruit a little later than the others, but produced larger and better shaped specimens. In wet weather the fruit of the staked plants were free from rot, but were badly sun scalded in hot weather. In wet weather the fruit of the untrained plant rotted very badly, but very little during the hot seasons. The staked plants were very near all dead by the middle of October, while the others continued to ripen fruit until after the first killing frost. The staked plants were cultivated through the summer and watered during the June drouth.

First of All (Wood). Ripened fruit five days before the other varieties tested, but can be recommended only on account of its earliness.

Fordhook First (Burpee). Five days later than the preceding, but superior to it in flavor, shape and solidity. The smoothest extra early variety tested.

Golden Queen or Yellow Trophy (Wood). Medium in size, smooth, prolific, and withstood drouth remarkably well.

King of the Earlies (Frotscher). Ripened with Fordhook First, but inferior to it in shape and size.

Large Yellow (Frotscher). Very irregular in shape and of poor flavor. The largest fruit weighed 15 ounces.

Livingston's Beauty (Wood and Frotscher). An excellent variety, crimson, smooth and continued in bearing until frost. Remarkably free from both rot and cracking. One of the best all-purpose varieties.

Livingston's Favorite (Frotscher). This variety seems to possess all the good qualities of the preceding and is a little larger; dark red, few seeds and very firm.

Livingston's Perfection (Frotscher). Neither as large nor as smooth as the two preceding, but an excellent variety.

Lorrillard (Wood). Large, smooth, prolific, rot-resisting and desirable both for home use and market.

Mansfield's Tree (Wood) An inferior, but strong growing variety.

Matchless (Wood and Burpee). One of the best varieties tested, but very susceptible to drouth. Very solid, smooth and free from core.

Ponderosa (Wood and Department of Agriculture). Large, smooth, drouth-resisting and superior to any other variety except in flavor. The largest specimen weighed 19 ounces.

Selected Trophy (Frotscher). Medium in both size and smoothness. Did not do well.

New Stone (Wood). Solid, coreless, smooth and the most regular in size and shape of any variety tested.

Radish.

Radishes were grown almost continuously from March until December 28, when the severe cold destroyed them. Seed were planted at intervals of from three to four weeks, early and later varieties being planted on the same date. From May to September their quality is greatly impaired by the hot weather, and are seldom eaten; but planted on the north side of taller plants that protect them from the hot sun their quality is greatly improved. Seed were planted thus, soja peas being used to furnish shade, and the radishes were in every respect superior to others subjected to the direct sunlight.

Radishes to be crisp and well flavored must be made to grow rapidly, for which rich, mellow and well prepared soil is necessary. Last spring a liberal top-dressing of one part each of nitrate of soda and muriate of potash, made when the roots were just beginning to enlarge and thoroughly worked into the soil, gave satisfactory results. Six days after the top-dressing was applied, radishes of the Scarlet Half Long French variety thus treated were *double* the size of the same variety not treated, and in a row only 3 feet distant. Lettuce alternated with radishes in 18-inch rows. The effect was as noticeable in the size of the lettuce and in the crispness of both. The following varieties were planted early in March:

Early Long Scarlet (Frotscher). A desirable variety, ready for market in thirty-eight days from planting.

Early Scarlet Turnip (Frotscher). Small, round, crisp and tender. Ready for market in thirty-two days from planting.

New Improved French Breakfast (Burpee). Skin dark red with white tips and very few leaves. Attractive in appearance, crisp and well flavored. Ready for market in thirty days from planting.

Scarlet Half Long French (Frotscher). Rich scarlet in color, very crisp, mild and well flavored, giving better satisfaction than any variety tested. Ready for market in twenty-eight days from planting.

The Glass (Department of Agriculture). Large, vigorous growth and good quality. The skin is frequently transversley cracked, which greatly detracts from its value as a market variety. Ready for market in thirty-six days from planting.

Turnip.

Several plantings of turnips were made, but the summer crops were invariably failures. In fact no results were obtained between the months of June and October. August and September plantings failed completely. The early spring and late fall crops did well.

Amber Globe. An oval yellow fleshed variety, succeeding best in fall. Flesh firm, brittle and sweet.

Early Purple Top Munich. Very early, succeeding well both spring and fall. An excellent table variety,

Early Red or Purple Top. An early, fine grained, sweet variety, cooking snowy white. The best for table use.

Early White Flat Dutch. Very early, but turning dark when cooked and is lumpy and flavor too strong. Recommended only on account of its earliness.

Golden Ball. Similar to the Amber Globe but larger and better flavored.

Large White Globe. Root and top second largest of any variety tested. Dark when cooked, stringy with strong and inferior flavor. Recommended for stock.

Purple Top Globe. A regular shaped, smooth variety of good size, mild flavor and free from stringiness when cooked. A good table variety.

Snowball. The largest variety tested, the roots being a little larger than the Large White Globe. The two varieties are very similar in growth, shape and flavor. Recommended for stock.

Yellow Aberdeen. Resembles the Rutabaga. Flesh firm, of good flavor and not stringy.

Three varieties of Rutabaga did nothing, the largest roots being not more than 2 inches in diameter.

The majority of the above varieties were cooked separately that their table qualities might be compared. *The Early Red* or *Purple Top* was superior in every respect to all the others.

Onion.

Bermuda grass greatly impaired the size of the six varieties of onions planted. The varieties succeeding best were *White Victoria*, *Prizetaker* and *Louisiana* or *Creole.*

More extensive experiments with onions are now under way.

Beet.

The soil upon which beets were grown was poor. It may never have been fertilized previous to the spring of 1894. They occupied plots from which Bermuda grass had been eradicated the year previous.

Columbia (Burpee). Failed. Ten of the largest roots averaged only 2 ounces each.

Danish Sugar (Burpee). Failed. Ten largest roots averaged only 3½ ounces each.

Early Blood Turnip (Wood). Ten largest roots averaged 11 ounces each. A good market and table variety.

Egyptian Early Red Turnip (Frotscher). A good table and market variety. Ten averaged 1¾ pounds each.

Extra Early or *Bassano* (Frotscher). Succeeded better than any variety tested. Was large enough for table use ten or twelve days before any other and ten averaged 3 pounds each.

Dirigo Blood Turnip (Dept. of Agri.). Poor stand. Largest one root weighed 3 pounds.

Stock Beet.

Golden Tankard (Wood). Early. Ten specimens averaged 2⅓ pounds each.

Long Red Mangel Wurzel (Frotscher). Ten roots occupying 10 feet in a row weighed 39½ pounds, the largest weighing 7 pounds,

Mammoth Prize Large Red (Wood). Ten largest roots weighed 18½ pounds.

Yellow Globe (Wood). Very regular in size and shape. Ten averaged very near 4 pounds each.

Carrot.

The four varieties of carrots did well when the fertility of the soil and character of the season are considered. The combined yield of the four varieties averaged 1 pound to every 28 inches of drill, or about 12,000 pounds per acre. The rows were 18 inches apart.

Danvers (Frotscher). Very smooth and regular in shape and bright orange in color. Gave the best yield; good flavor.

Early Scarlet Horn (Frotscher). Medium in size, well flavored and early.

Improved Long Orange (Frotscher). Gave the second best yield. Flavor inferior.

Long Red (Frotscher). Good flavor and productive.

Lima Bean.

Three varieties of lima beans were grown all of which blossomed profusely, but only one set fruit. The blossoms would drop off just after they expanded. *Burpee's Bush*

Lima and *Jackson Wonder* yielded almost nothing. *Wood's* or *Henderson's Bush Lima* produced a fair crop, setting less than half the blossoms that opened.

Snap Bean.

Three new varieties of snaps gave excellent results and deserve to be highly recommended. They were:

Burpee's New Stringless Green Pod Bush Bean.

Thorburn's Extra Early Market Bean.

Wood's Earliest Hardiest Bean.

Garden Pea.

Four new varieties were planted:

Echo (Burpee). Dwarf, prolific and promises to succeed well.

Melting Sugar (Dept. of Agri.). Prolific. The very large pods are edible. Did well.

Renown (Burpee). Not prolific, but the pods are well filled.

Sterling (Dept. of Agri.). Rank vine growth, but few pods and imperfectly filled.

Cauliflower.

Cauliflower to make good heads requires rich soil, not too much sun and an abundance of water. The plants should be grown very early in the spring. The varieties tested were not planted until late spring and succeeded only moderately well.

Burpee's Best Early (Burpee). Six of ten plants headed. The largest head measured 4½ inches across. White, tender and moderately compact.

Snowball (Frotscher and Department of Agriculture). Six of ten plants made loose heads inferior in every respect to the Best Early.

Half Early Paris (Frotscher). Failed to head.

Le Normand's Short Stemmed (Frotscher). Seven of nine plants headed. Heads were not compact but white and tender.

Large Algiers (Frotscher). Failed to head.

Two Varieties of Garden Corn.

But two varieties of garden corn were planted, the Early Fordhook and Zigzag Evergreen. The seed of the Fordhook were distributed by Burpee and the Zigzag Evergreen by both the National Department of Agriculture and Northrup, Breslan and Goodwin.

The Early Fordhook is very early and an excellent garden variety if planted on fertile soil.

The Zigzag Evergreen is later than the Fordhook, but in other respects far superior. It is prolific, with large, well filled ears and endures drouth remarkably well, and succeeds in soil less fertile than is required for the Fordhook.

Burpee's Meltrose Melon.

This is a new and excellent variety with very thick and solid flesh of light green color shading to salmon at the seed cavity. The melons are nearly round, densely netted and with a faint suggestion of ribs. Seed cavity very small, the flavor excellent. It promises to be a valuable melon for both market and home use.

Peanuts.

Of several varieties of peanuts planted the Spanish was the only variety that amounted to anything. The red and white Virginia and Tennessee varieties barely producing the seed that were planted, notwithstanding a liberal application of acid phosphate and lime. Pops, or the empty hulls, were produced in fair quantities, but barely 5 per cent contained even one seed. On the other hand the Spanish made a large yield with a remarkably small per cent of pops. This variety cannot be too highly recommended for this soil. Planted without fertilizer on a poor hillside this peanut yielded upward of 50 bushels per acre, while Whippoorwill peas on the same soil barely made 5 bushels of peas and very little more hay than the peanuts. The maximum yield of Whippoorwill peas in the hulls gathered in 1894 from the Southern Branch Station was 1,330 pounds per acre, or about 15 bushels of peas, while the maximum yield of Spanish peanuts was 4,305 pounds per acre, or 143½ bushels.

Spanish Peanuts Planted Different Distances.

On July 19 three plots of Spanish peanuts were planted on soil that had previously been manured for the double purpose of determining how late in the season they might be planted and yield profitably, and to compare the yield from plantings of different distances. When the first blossoms appeared each plot was given a top-dressing of 100 pounds each per acre of nitrate of soda, muriate of potash and acid phosphate, which was cultivated into the soil with a garden rake. The plots were at all times cultivated by hand with the rake and hoe, a plow being used only in the preparation of the soil. The table gives the distance the peanuts were planted and the yield per acre.

Planted 12x 4 inches	143½	Bushels.
" 12x12 "	102	"
" 12x24 "	91	"

They were gathered after the first killing frost, which occurred on October 30, and the estimate made from mature and dry peanuts. About 10 per cent (measured) were immature when dug.

Three important conclusions may be drawn from these results:

1. In good soil Spanish peanuts may be planted thicker than is generally the custom.

2. In moderately fertile soil with frequent shallow cultivation, they produce remarkably well in dry and hot weather (See Meteorological Summary).

3. They may be planted after oats, wheat, rye or barley have been harvested and give a remunerative yield.

Yields of Spanish Peanuts and Corn Compared.

A plot of corn planted on poor upland and fertilized with 200 pounds cotton seed meal per acre, gave a yield of a little less than 10 bushels of nubbins and poorly filled ears. The yield was curtailed by a drouth coming just as the tassels and silk appeared. A plot of Spanish peanuts planted on soil possibly a little less fertile than occupied by the corn produced 58 bushels per acre without the use of fertilizer. Valuing the corn at 50 cents per bushel and the peanuts at 25 cents, the gross receipts per acre are:

10 bushels of corn at 50 cents	$ 5.00.
58 bushels of peanuts at 25 cents	14.50.

Applying the same prices to the maximum yields of corn and peanuts per acre grown in 1894 on this Branch Station we have:

143 bushels peanuts at 25 cents	$35.75.
40 bushels corn at 50 cents	20.00.

The soil, however, that produced the 143 bushels of peanuts would not have yielded 40 bushels of corn in a good season, and half that quantity would have been a large yield for 1894. This comparison is made in the interest of hog raising. Spanish peanuts planted in the oat field after that crop is harvested would put hogs in an excellent condition by December, when they could be penned, fed on corn for a few weeks and then butchered.

Yield of Forage Plants on Poor Land.

On light sandy soil that grew cotton in 1893 and corn in 1892 were planted several forage plants that a comparison of their yields might be made. The fertility of the soil was about equal to that of the ordinary upland in this portion of the State. Three hundred pounds of cotton seed meal were used under the cotton in 1893, and the same amount per acre under the forage plants. The unfavorable season curtailed the yield considerably, but little over half an inch of rain falling in June. The soil was plowed twice before April 13, on which date the seed were planted in 3½ foot rows, unless otherwise noted. The figures represent the green weight at the time of cutting.

NAME OF PLANT.	Green weight per acre in pounds.
Early Amber Sorghum	4,780
Yellow Millo Maize	4,475
Pearl Millet (cut three times)	9,600
Jeruslalem Corn	2,820
"Kaffir"	3,870
Red Kaffir	5,900
Rural Branching Sorghum	3,810
Teosinte (half stand)	1,709
Soja Beans (rows 3 feet apart)	13,120
Indian Corn	4,380
Sugar Beets (rows 2 feet apart)	6,170
Jerusalem Artichokes	4,200
Broom Corn (Panicles with seed)	988
Sweet Potato (common yam)	3,512½
Sweet Potato (bunch yam)	4,550
Spanish Peanuts (rows 2½ feet), (dry weight vines)	1,740
Pumpkin (hills 8 x 8 feet)	12,000
Kansas Stock Melon (hills 8 x 8 feet)	44,516

Kansas Stock Melon.

This melon belongs to the citron family and is used for stock food. The seed were distributed by the National Department of Agriculture.

This year under very unfavorable climatic conditions the stock melon was enormously productive, yielding at the rate of 44,516 pounds per acre, the largest melon grown weighing 33½ pounds. The vines spreading over a considerable area, one of which measured 31 feet from root to opposite end.

The seed were planted in poor soil in hills 8x8 feet, two plants being left to each hill. Each hill was fertilized with a shovel full of stable manure and cotton seed mixed, and about half a pound each of nitrate of soda, muriate of potash and acid phosphate. The melons were fed to hogs, mules and cows, but only the latter ate them with much relish.

C. L. NEWMAN.

MONTHLY AND ANNUAL METEOROLOGICAL SUMMARY, CAMDEN, ARK., 1894.

MONTH AND YEAR 1893.	TEMPERATURE.					Precipitation In inches.	NO. OF DAYS.			
	Mean.	Maximum.	Date.	Minimum.	Date.		Rainy. 01. in. or more.	Cloudy.	Part Cloudy.	Clear.
January										
February	43.6	71	18	22	16-24-26	4.05	10	14	11	3
March	56.5	85	13	24	27	11.87	11	13	8	10
April	65.4	88	28	37	2	7.77	11	13	3	14
May	72.6	93	17	40	20	1.58	7	7	13	11
June	77.5	101	30	48	7-8	0.55	1	10	12	8
July	79.2	103	1-4	58	23	6.26	7	7	7	17
August	78.5	99	13	58	6	2.69	11	15	14	2
September	74.4	97	7	46	27	1.30	4	10	10	10
October	63.2	92	1	29	31	1.22	2	4	5	22
November	50.3	81	1	25	18-20	1.38	1	8	5	17
December	46.0	74	8	8	28-29	3.04	10	13	4	14
Annual		103	July 1-4		Dec. 28-29					

First killing frost, October 30.
Last killing frost, March 30.

APPENDIX.

The following seedsmen will, upon application, mail seed catalogues free to any address:

Richard Frotscher, New Orleans, La.
T. W. Wood & Sons, Richmond, Va.
Alexander Drug and Seed Company, Augusta, Ga.
Plant Seed Company, St. Louis, Mo.

ANIMAL PATHOLOGY.

Some Diseases of Farm Animals.

In this bulletin a short account will be given of those diseases of farm stock not described in previous bulletins, about which there has been the greatest amount of inquiry by correspondence, or which have been found during the investigations of the past year to have been the most prevalent and destructive.

It may be as well to emphasize here what has been said in previous bulletins in regard to stock diseases, that the hope of diminishing the losses from this cause must rest on a better understanding by the farmer of the causes which bring about diseases in his stock much more than in any knowledge which he may acquire as to the manner of treatment. Indeed, one of the first fruits of such an understanding is to show the folly of much of the treatment to which diseased animals are often subjected.

The inquiries received here, by correspondence, as to farm stock during the year have been as usual, chiefly in regard to contagious or endemic diseases of cattle and hogs, and to diseases of a sporadic nature affecting horses.

Undoubtedly the greatest losses on account of disease in animals in this State occur among hogs. Some remarks upon the subject of swine diseases and their connection with the manner in which these animals are raised will be found further on in this bulletin.

With the exception of "cholera" of hogs and occasional limited outbreaks of Texas fever in cattle, it may be said that diseases due to animal parasites are those which are chiefly complained of. Several of these have already been described in previous bulletins. One disease of this nature which seems to be the cause of considerable trouble in certain parts of the State will be described here.

Verminous Bronchitis.

Verminous or parasitic bronchitis occurs in cattle, sheep and hogs. It is found chiefly in the lower regions bordering on the rivers subject to overflow, and in swampy parts of the State, and doubtless forms one of the obstacles to the successful raising of sheep in such localities. It is not very common in cattle here, at least to such an extent as to cause serious trouble, but one or two instances have been reported to me of very extensive losses from this cause.

The disease in the three kinds of live stock referred to is caused by the presence, in the air tubes and lungs, of small round worms belonging to the genus *strongylus.* There are several species of this genus of worms which are found as parasites in the domesticated animals, inhabiting other parts of the body as well as the bronchi, but it is in the latter situation that their presence gives rise to the most serious symptoms, on account of the irritation and inflammation of the lining membrane of the air tubes thus induced.

In hogs this condition seems to be common enough, but it is difficult to estimate the losses directly due to this cause, or indeed, to say whether or not it is ever the immediate cause of death in these animals. That it may interfere with their growth and vitality and thus render them more liable to succumb to other more fatal diseases there can be no question. In this respect it acts in conjunction with a number of other parasites with which hogs are very frequently infested.

In horses lung parasites of this kind have also been found, but disease from this cause seems to be rare.

Among cattle and sheep, in regions where the pastures have become infested with these parasites, the losses from parasitic bronchitis and pneumonia are often very great, this condition, indeed, rendering the successful raising of such stock an impossibility on infected farms.

The *biology* of the parasites, so far as it is known, appears to be nearly alike in all the species. The air passages of the infected animals are the natural habitation of the worms in their adult form as well as in part at least of the period of their growth. Just as earth worms, for instance, would be unable to live as parasites in animals, so these strongyles are unable to live and propagate their kind in the earth. In this case, therefore, as in the case of all true parasites, the presence of the proper host (sheep, cattle, etc.,) is necessary for the continued existence of the species. The young of these worms having gained entrance into the air passages of their host, grow to maturity there, and the females then lay their eggs in the smaller bronchi or air tubes. The eggs, which in most cases contain the embryos in a partly developed condition when deposited, soon give exit to the latter, which, often in immense numbers, continue their development up to a certain stage in the same situation, so that a diseased lung contains both the embryos and the mature forms of the parasite at the same time. The young, however, do not develop to maturity in the air passages of their original host, but require first to be passed out to the external world. This is a feature of their life history in which they resemble the majority of internal parasites. The undeveloped forms, as well as the adults, are cast out by the coughing to which their presence gives rise, and thus distributed on the pastures. After passing through some further stages of development external to their original host, the immature forms are again ready to be taken up by cattle or sheep, as the case may be, and complete their development where it was begun, namely, in the air passages and lungs. What change these embryos undergo in the outer world, whether or not they pass through some intermediate host, as is common in other species, and in what way they are taken up by their ultimate host, are parts of their life history which are as yet undiscovered. It is known, however, that pastures become infected in the way described above, and that previously healthy animals grazing on these pastures soon become invaded by the worms, and the presumption is that the latter are taken up with the food or drink, or both, or, as has also been suggested, by inhalation of the embryos in a dried state. In the latter case they would attain directly to their place of predilection, the air tubes; if taken in with the food or drink they would of course require to migrate in some way from the stomach to the respiratory passages. How this is accomplished is not positively known.

The embryo worms are capable of living on the pastures for a considerable time, the exact duration of which is not known. Wet pastures and those containing many pools of stagnant water are much more favorable to their continued existence than dry pastures, if not absolutely essential to it. It has been stated, however, that at a certain stage one species of these parasites at least is capable of surviving a desiccation of several months' duration; but all experience, in countries in which verminous bronchitis is more common than it is with us, shows that wet and marshy fields furnish the conditions under which it commonly occurs.

The *disease* which these parasites produce varies in severity in different species of animals—hogs, cattle or sheep. It also varies in different animals of the same species according to the number of parasites present and the ability of the animal to resist their invasion, weakly animals being always more subject to the invasion of parasitic organisms than healthy ones. The irritation produced by the presence of the worms, both adult and immature, and the products of their growth, gives rise to an inflammation of the lining membrane of the air tubes and of the lung tissue, which leads to more or less extensive consolidation of the lung and interferes with its function.

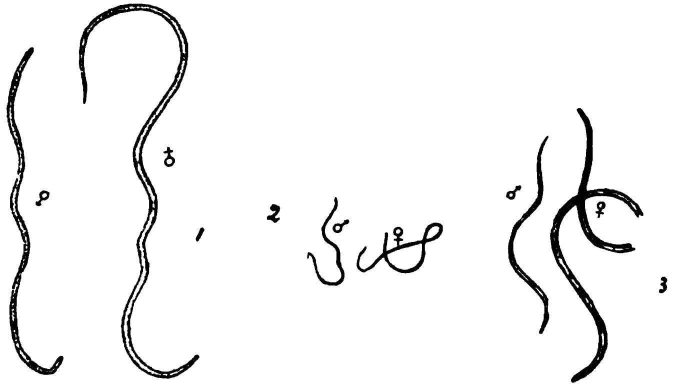
The disease is continuous as long as the exciting cause is present, and gradually undermines the strength and vitality of the animal. Interference with breathing also occurs from masses of parasites blocking up the tubes and leading on occasions to symptoms of suffocation. The course of the disease is usually slow, extending throughout the summer, and as already said, it varies greatly in intensity in different animals.

Symptoms: These are often not very manifest at the beginning of the attack or in cases of little severity, lungs diseased in this way being often found on the slaughter of animals which, during life, showed no symptoms at all. But when a flock becomes infected there are usually some which are affected in a more severe form and in which the symptoms are sufficiently plain to indicate the disease.

In *sheep* the disease may occur in animals of all ages, one form being more common and severe in lambs, whilst another form is more frequently found in adults.

Signs of difficulty of breathing, coughing, which often occurs in paroxysms, with sometimes symptoms of suffocation, discharge from the nostrils and rejection of small masses of worms during the fits of coughing, progressive loss of flesh and an unhealthy appearance of the wool are symptoms which may be observed in well marked cases. The substance expelled from the nostrils in coughing sometimes contains worms which can be readily seen with the naked eye, and in such a case there would be no difficulty in identifying the disease. The smaller species of worms, however, and the embryos are too small to be recognized without the aid of a magnifier. The fact of a considerable part of the flock being affected similarly at the same time would furnish further evidence that the trouble was due to some such cause as this. Many of the animals affected will die during the course of the summer or autumn, while others will recover during the succeeding winter and spring if not subjected to further infection.

Figure 1, which is an outline sketch of an alcoholic specimen of the parasite obtained from sheep in St. Francis County, shows the general appearance and size of the adult form of one species affecting sheep. Another species, that which is most common in older sheep, is much smaller, and seen in its natural size in Figure 2.



LUNG PARASITES OF SHEEP AND CATTLE. (Natural Size.)

1. *Strongylus filaria.* (From sheep.)
2. *Strongylus rufescens.* (Neumann.)
3. *Strongylus micrurus.* (Neumann.)

In *Cattle* the disease runs the same course and the symptoms resemble in a general way those seen in sheep, but adult animals are not affected to any serious extent, the disease being confined for the most part to calves under 1 or 1½ years of age. As in the case of sheep, it occurs only in animals which are or have been on pasture and the infection is obtained in the same way as that already described for sheep. When only slightly infected there may be no marked symptoms, but in severer cases there is coughing, which tends to occur in fits or paroxysms, with difficulty of breathing, threatening suffocation, slavering and discharge of mucus from mouth and nostrils, in which may be seen the adult worms, single or in numbers intertwined together. These are about the same size as the larger species found in sheep, and are represented in Figure 3.

The duration of the disease varies. Sometimes calves die in a few weeks; in others, they linger for months, showing, along with the symptoms above described, also the usual signs of unthrift, with final loss of appetite and great emaciation.

In hogs, which often harbor in their air passages one species of these strongyles and suffer to some extent from the irritation and inflammation induced by their presence, acute or well-marked symptoms of verminous bronchitis or broncho-pneumonia are uncommon.

The changes found after death in infected lungs are also less marked than in cattle and sheep, but there is no doubt that these parasites often interfere with their health and growth, and render them more susceptible to other diseases. Young pigs may die with, in general, the same symptoms as those described.

In both old and young, however, the presence of these worms gives rise to a certain amount of irritation in the bronchi, of which the coughing so commonly heard in these animals is a prominent symptom, although it should not be inferred that coughing in a herd of hogs is always due to this cause.

Prevention and Treatment.—The means which may be adopted for the prevention and mitigation of parasitic diseases in farm animals must be based on an understanding of the manner in which these diseases are produced, and this implies a knowledge of the life-history of each parasite. In certain respects, however, the remarks which may be made under this head apply to all the most common parasitic affections found in animals. In certain years, chiefly those in which the preceding winter is mild and the summer unusally moist, the conditions for the intermediate existence of many parasites (that stage which they pass outside of their ultimate host) are favorable, and consequently parasitic diseases are more common than in years in which the opposite conditions prevail. It is a common belief among farmers in this State, at least, that whenever there is an abundant crop of acorns the hogs will suffer in the following spring and summer from worms, and also that such a season is very often followed by cholera. There is no reason for believing that hogs obtain parasites from acorns, but the explanation is rather that those years which are favorable for the growth of acorns are also such as favor the propagation of parasites, and probably also that in rooting after these acorns hogs take up parasites from the ground at the same time. Except in so far as internal parasites may weaken the vitality of the animals, thus rendering them more prone to suffer from contagious diseases when introduced, there can be no connection between hog cholera and worms.

In the prevention of verminous bronchitis in sheep or cattle it is important that the disease be recognized early before much of the stock becomes seriously infected, for badly diseased animals are not successfully treated. When the disease does appear, and has been recognized by the symptoms given above, all the healthy animals should be (when this is possible) put on new pasture. Diseased animals also ought to be removed onto another pasture, but kept separate from those which are as yet not manifestly infected. The pastures should be as high and dry as possible, and free from stagnant pools of water. Good water, either from wells or from running streams, should be supplied to all farm animals, the common practice of compelling them to drink out of stagnant and slime-infested pools being a direct invitation to disease. All kinds of stock should not only have access to pure water, but access to filthy water should be prevented by fencing, as animals sometimes acquire a habit of drinking impure water in preference to good water.

The further means of limiting the spread of the disease is by supplementary feeding of dry, nourishing food in some form, and free access to an abundant supply of salt. Pastures should be frequently changed, as the constant grazing of one kind of stock on the same field, year after year, tends greatly to increase the infection when once it has been introduced. It is in the spring of the year, and in the case of young animals especially, that these precautions are most needed.

The treatment of sheep affected with this disease, except in the general manner indicated above, is not likely to be profitable. It is important that in the spring of the year they have an abundance of food, as any debility greatly increases the danger of infection with parasites. Lambs, having certainly become infected in this way, if in good condition, had better be sold at once for butchering if there is any market. Both for sheep and young cattle, it has been recommended to attempt to remove the worms from the bronchi by inhalation of irritating gases, such as that arising from burning tar, rags, hair, leather, etc., or from burning sulphur. The sheep are driven into a close shed during the process of treatment, and exposed to the fumes as long as these can be borne with safety by the operator himself. In the case of a small flock of valuable sheep thus affected, treatment of this kind may be profitable, as well as tracheal injections, which have been more widely tried in the treatment of calves.

In this latter mode of treatment, the medicine is injected by means of a suitable syringe (hypodermic) into the lumen of the windpipe, between its rings, and in the middle line where the tube is nearest the surface. Preparations, containing turpentine and carbolic acid, have been mostly tried in this way. Turpentine may be injected, diluted with equal parts of sweet oil; carbolic acid should be diluted largely. When mixed, half a tablespoonful of turpentine may be combined with twelve to twenty drops of carbolic acid and an equal volume of sweet oil, well shaken together. Two or three injections, at least, will be necessary, and at several days interval. Such a method of treatment, however, should not be attempted except by those who are willing to take the time and care to do the work carefully and yet thoroughly.

Parturient Apoplexy of Cows.

Inquiries as to the cause and treatment of this disease are not uncommon, and as it is an affection with which it is desirable that the farmer, and more especially the dairy farmer, should be acquainted, a few pages may be profitably devoted to this subject.

Known also by the name "Milk Fever" this disease is of common occurrence on dairy farms especially where the improved breeds of cows are kept and these highly fed and stabled, but these conditions are not essential to its occurrence.

Nature and Symptoms. Parturient apoplexy is a disease connected with calving and one which we need consider only as it affects cows. It practically never appears except at this time and in nearly all cases within a week after the birth of the calf. It may appear almost immediately after this event but this is rare, the most common time being from the twelfth hour to the third day.

The following series of symptoms are those which would be most readily noticed by the farmer and should be sufficient for identifying the disease:

It occurs, as above mentioned, as an occasional sequel to parturition only, from a few hours to several days after calving; cows attacked are chiefly those which are in good condition and heavy milkers, or those which, even if not fat, have been fed highly for some time before calving. Constipation, exposure to cold, and imperfect withdrawal of the milk after calving, are also considered to be predisposing causes, but the most important point in this connection, and one which should be remembered, is that a first attack strongly predisposes to a second; in other words, an animal which has once been down with this disease and recovered is very liable to be attacked again at the next calving. The disease commonly follows an easy delivery and not, as might be supposed, a difficult one. It seldom occurs in connection with the first calving but has been observed most frequently from the third to the eighth, that is, during the time that the cow is at her best as a milker. Retention of the afterbirth is occasionally observed in connection with parturient apoplexy but this seems to be an exception and it is not believed that there is any connection between the two conditions.

As warning symptoms of the disease there may be seen in some cases: constipation, diminished flow of milk and partial suppression of urine, followed by restlessness manifested by shifting of the hind feet and frequent lying down and rising again. The ears and base of the horns feel hot and the eyes appear bloodshot. The restlessness increases and finally, the cow gets down and is unable to rise again from loss of power in the hind limbs, but still retains power over the fore limbs and head which may be thrown violently around or dashed against the ground or adjacent walls. At a further stage the head is held persistently in one position with the nose turned to the region of the flank, or the neck may be extended straight forward with the nose resting on the ground. All or nearly all power of movement of the limbs then becomes lost,—there is paralysis not only of motion but also of sensation. Pricking of the skin with the point of a knife in any part of the body calls forth no movements of defense. The animal is then in a state of *coma* from which she cannot be roused. She may lie prone on the side or may retain a position on the breast. The eyes become glazed and irresponsive to touch and finally death results in from twelve to twenty-four hours, from the paralysis extending to the heart and respiratory centers.

The foregoing may be taken as the symptoms of a typical fatal case but there are variations both in the mode of onset and the course of the disease. The onset may be more rapid, without any premonitory symptoms, and the disease run its fatal course in a few hours; or the symptoms may be more slowly developed, the motor paralysis and comatose condition less complete and the power of swallowing retained; such cases often terminating in recovery. There are also cases in which an unlooked for recovery ensues in a very short time when properly attended to even when all the symptoms above described have been exhibited.

Of the *nature* of the disease, that is, the morbid condition giving rise to the train of symptoms described, and the cause of that condition but little is positively known and it is unnecessary in this article to enlarge to any extent on this part of the subject. It is generally regarded as a disturbance of the circulation in the brain brought about by the act of parturition and the subsequent rapid contraction of the womb which occurs in such cases. According to another theory it is ascribed to an intoxication or poisoning of the nerve centers from absorption of toxic substances engendered in the uterus by the growth of bacteria there. Neither of these theories, however, have been satisfactorily demonstrated by patho-anatomical investigation.*

Whatever may be the immediate cause, the symptoms and to some extent the post-mortem lesions support the view that there is in the first stages of the disease a hyperæmic condition of the brain, which is followed later by an œdema and consequent anæmic condition, and it is on this assumption that the most general and successful treatment is based.

---

*That bacteria are present, at least in some cases, in the contents of the uterus of cows which die from parturient apoplexy I have had the opportunity of establishing from an examination of a few cases. From lack of material it was impossible to make a thorough investigation of this subject, but the following points were established:

(1.) In three cases (all that were obtainable in a condition suitable for such examination), bacteria were found in the fluid or semi-fluid contents of the uterus immediately after death. In one case cocci in pairs and short chains were present in sufficient numbers to be readily recognized on cover-glass preparations; in the two other cases bacteria could not be demonstrated microscopically, but were obtained in cultures from such material. They were evidently present in very small numbers and of various species, including cocci and anærobic spore-bearing bacilli.

(2.) The bacteria thus obtained in cultures were innocuous when injected subcutaneously to guinea pigs.

(3.) The contents of the uterus, in all three cases, when subcutaneously injected into guinea pigs in doses of 1 cc. proved non-toxic and non-infective for these animals.

Prevention and Treatment. The disease is one which calls for skilled advice whenever this is attainable, and one in which a fatal result may easily be produced by improper treatment. Any methods and remedies which cannot be applied with safety by the farmer himself would manifestly be out of place in this article. The directions here given however, if carefully followed, should be the means of saving many animals which otherwise would be lost.

As a rule it is found that the sooner the disease appears after calving the more likely it is to prove fatal. The suddenness and severity, or comparative mildness, of the onset also supplies an indication as to the result. In all cases it is important that the first symptoms should be recognized in order that treatment may be commenced early. In the case of cows which have already suffered from a previous attack, and even in the case of others which present conditions very favorable for the disease, such as already described, preventive treatment should be commenced before parturition. This consists in limiting the supply of food during the time that the cow is dry, and keeping the bowels open by one or more doses of salts. The most suitable purgative for a cow is one to one and a half pounds of Epsom or Glauber's salt with an ounce of ginger and about a pint of molasses in a large quantity (two quarts or more) of tepid water.

After calving a free flow of blood to the udder should be encouraged by frequent milking even if the calf is allowed to suck, and the animal of course should be protected from exposure to severe weather or to unusual cold or heat, although a certain amount of daily exercise is desirable. If the first symptoms of the disease should appear the purgative medicine should be given again at once. The further medicinal treatment of the case is more difficult to prescribe in a positive manner as the conditions are not alike in all cases. As a rule it will be found that in this stage of active cerebral congestion the best results will be obtained by the use of aconite, of which the tincture should be given in the dose of twenty to thirty drops and repeated in doses of half that quantity every three hours till four or five doses have been given.*

Before drenching, especially when large doses such as the purgative mentioned above are given, it is necessary to see if the animal retains the power of swallowing perfectly, which may be done by drenching first with a small quantity of water. There is usually no difficulty in this respect in the first stages but after the cow gets down more or less paralyzed there is often inability to swallow and in such case no attempt should be made to administer medicines by the mouth. Medicines which are given in small quantities can best be administered by means of the rubber bulb and cane (See Bul. No. 25). Wherever an attack of this kind is feared the cow should be kept in a well ventilated stable or shed. After it gets down and is unable to rise, and the full symptoms of the disease appear, attention should first be given to the position of the animal. If in the open field it is necessary that shelter be provided in some way against the sun's rays; the animal should be placed in such a way that the head will be at least not lower than the body and kept in that position by constant attention; a position prone on the side should be prevented by means of sacks stuffed with straw as supports; the limbs should be well rubbed with mustard and water or with turpentine, and kept warm by cloth bandages; cold should be applied to the head by means of ice bags between and behind the horns or by frequent and continued douching with cold water. If no medicines have hitherto been administered those above named should be given. If there is difficulty in swallowing the dose of salts should not be given at all, and later, it may be necessary to refrain from all drenching for the same reason. At a later stage

---

*Medicines such as aconite, which are highly poisonous, should not be kept in stock except in very careful hands, but should be obtained at the drug store as required. The following prescription meets the requirements for the case now under discussion:

Tincture of Aconite	One Fluidrachm
Water	Ten Fluidounces

Give half at one dose and remainder in three doses three hours apart.

there is commonly feeble action of the heart and this has to be combated by stimulants such as whisky, of which one pint may be given in water at intervals of a few hours.

Further directions should include turning of the animal so as not to allow it to remain too long in one position, injections of warm diluted soap-suds into the rectum, and, if bloating of the stomach with gas occurs, puncturing on the left side of the abdomen by means of a trocar and canula in the manner with which most farmers are familiar. Drinking water should be supplied freely and the udder stripped of any milk that may be secreted.

Cases of parturient apoplexy terminate either: (1) In rapid and complete recovery; (2) in recovery from the apoplectic condition but with a certain amount of motor paralysis, which persists for a variable time; (3) in death, generally within the first day or two after the beginning of the attack and without recovery of consciousness; (4) recovery from the paralysis is followed shortly by a broncho-pneumonia the result of food regurgitated from the stomach into the windpipe. In the first case, that of complete recovery, no further directions are necessary except that the diet should be somewhat restricted for the first few days. When there is apparent inability to rise after recovery of consciousness and appetite a mustard friction along the spine is beneficial. The paralysis in such cases is not often of long duration.

The traumatic form of pneumonia which follows parturient apoplexy is seldom successfully treated.

In conclusion, the warning already uttered should be repeated: that cows which have once been down with this complaint are extremely liable to suffer again at the next calving and consequently should in general be disposed of for beef.

Hog Cholera and Other Swine Diseases.

As has been said the yearly loss from diseases of hogs seems in this State to be greater, perhaps, than that from all other diseases of farm stock combined. During the year a number of places were visited on the request of farmers who were losing their hogs from disease supposed to be cholera.

Hog cholera, of course, refers properly to a definite disease, but on account of its being the best known (by name) of all swine diseases it is often conveniently used for all diseases of these animals which appear to be of a contagious or endemic nature.

Of the outbreaks of disease in herds of swine which have been investigated the greater part have been found to be due to cholera, but others were examined in which the lesions of this disease could not be detected. That internal parasites very frequently constitute either the only cause or a very powerfully assisting cause of death has already been intimated. In young pigs external parasites also, in the form of the scab or itch insect, sometimes cause the death of whole litters. This subject has been discussed in a previous bulletin.

There is no doubt that the manner in which hogs are generally raised in the South contributes greatly to the spread of such contagious diseases as hog cholera and also favors the development of other of the fatal diseases from which they frequently suffer. The objectionable features referred to are, that during the first months of their growth pigs are often compelled to find their living on the range and in the woods, and on account of this process of semi-starvation they are not only stunted in their growth but also constitutionally enfeebled and thus rendered more susceptible to disease; they are compelled or allowed to drink from pools of stagnant water from which they become infested with internal parasites; and on account of the free intercourse with herds of neighboring farms any contagious disease which may be introduced rapidly spreads throughout all the herds in the district.

As a means of lessening the losses from such diseases and otherwise contributing to the more profitable raising of hogs the following suggestions may be made, which the practical farmer can apply in accordance with the facilities at his disposal:

1. A more liberal supply of food (grains or grasses other than the weeds of the prairies or woods) is needed during the summer months.

2. The water supply should be from wells where possible; otherwise, from running streams and not stagnant pools.

3. Only a limited amount of range should be allowed at one time and this changed several times during the year. Hogs should not be pastured on the same field in successive years.

4. By proper fences each farmer should keep his hogs on his own farm and his neighbor's out of it; this is especially necessary when disease is in the neighborhood.

When a contagious disease appears among hogs the most important thing to be attended to, and that which is most frequently neglected, is to separate the well from the sick animals at once. This has usually to be done by removing those as yet unaffected to another pasture or lot, not, as is sometimes done, by taking out the sick and leaving the well where they are. If any more become sick a further separation will be necessary. Hog cholera being the most common and fatal of such diseases it is important that the farmer should be able to recognize it. The following published by the Iowa State Board of Health is a sufficiently accurate and complete description of the symptoms:

"The presence of the disease is indicated by cold shivering, lasting from a few minutes to several hours; frequent sneezing, followed by loss of appetite, rough appearance of the hair, drooping of the ears, stupidness, attempts to vomit, tendency to root the bedding, to lie down in dark and quiet places, dullness of the eyes, often dim; sometimes swelling of the head, eruptions of the ears and other parts of the body; dizziness, laborious breathing, vitiated appetite for dung, dirty and salty substances; accumulation of mucus in inner corner of the eye, discharge from the nose; fetid, offensive discharge from the bowels, offensive exhalations; diarrhœal discharges are semifluid, of grayish green color, and often mixed with blood. In many cases the skin on the belly between the hind legs, behind the ears, and even on the nose, has numerous red spots, which, toward the fatal termination, turn purple. As the disease progresses the animal becomes sluggish, the head droops, with the nose hid in the bedding. If there has been costiveness, about two days before death there will be offensive fetid discharges, the voice becomes faint and hoarse, the animal is stupid, emaciation increases rapidly, the skin becomes dry, hard and unclean; there is a cold, clammy sweat, and death soon follows with convulsions, or gradually by exhaustion, without a struggle. In chronic cases or those of long duration the animal becomes weak, lies down most of the time, eats but little and has diarrhœa. These cases may linger for weeks, scattering the poison of the disease in the discharge wherever they go."

Examinations made after death should assist in identifying the disease; the large bowels in a typical case will be found to contain ulcers of varying size.

Treatment of Hog Cholera—The disease has generally been considered as little amenable to treatment although numerous remedies are on the market. Most of these hog cholera remedies will be found profitable only to those who sell them. In Farmer's Bulletin No. 24 of the Department of Agriculture a remedy is recommended which we have had no opportunity of testing but of which we have seen a number of favorable notices, and which is here produced:

	Pounds.
"Wood Charcoal	1
Sulphur	1
Sodium Chloride	2
Sodium Bicarbonate	2
Sodium Hyposulphite	2
Sodium Sulphate	1
Antimony Sulphide	1

"These ingredients should be thoroughly pulverized and mixed. The dose of this mixture is a large tablespoonful for each 200 pounds weight of hogs to be treated. Give only once a day."

It may be mentioned, finally, that a certain amount of protection is supplied by feeding the well hogs on a farm on which hog cholera has appeared with the thoroughly boiled blood, flesh, and organs of those which die from the same disease. This, which is a rough application of the recently developed method of treatment of bacterial diseases by "serum-therapeutics," has been insufficiently tested to justify any stronger statement than that it certainly confers some protection, and when properly carried out is harmless. The necessary precautions are, that the cooking be sufficient to destroy all the germs, this being obtained by mincing the flesh, etc., and boiling with an equal weight of water for about half an hour; that the cooking be done before decomposition takes place; and that the animals be watched while feeding to prevent over dosing.

The practice which some farmers have of allowing dead hogs (uncooked) to be eaten by others in the herd is one of the surest ways of communicating the disease. Dead hogs should either be burned or deeply buried.

Tuberculosis of Cattle.

In this State there is comparatively little call for information on this subject which is, however, largely engaging the attention of State sanitary authorities and live stock commissioners in the East. Where the improved breeds of cattle are raised and in the larger dairies in and around cities this contagious disease, allied in its nature to pulmonary consumption of mankind, is in this country the worst scourge to which the bovine race is subject. From a considerable experience in the inspection of cattle at the slaughter houses in different parts of the State the writer is in a position to state that the disease is practically unknown among the native Arkansas stock. This immunity is due no doubt partly to the inherent hardiness of such stock, but perhaps in greater measure to the manner in which they are raised, the mildness of the climate allowing of cattle being pastured all the year round. They thus escape the close and continued stabling which contributes so largely to the development and spread of this disease Nevertheless tuberculosis of cattle is not entirely unknown in Arkansas, several herds having been examined, by request, in which the disease was established by the use of *tuberculin* an invaluable diagnostic agent which science has now placed at our disposal.

The remarks contained in this article, for the reasons above stated, are of importance chiefly to those who own or contemplate making importations of improved stock which this State stands so much in need of.

Only a very brief reference to the nature and symptoms of the disease will be given.

Tuberculosis of cattle has for its causes, usually operating conjointly with each other:

1. The *predisposition* arising by reason of the artificial mode of life common among the improved breeds of cattle; this includes especially the drain on the vitality from an excessive secretion of milk, the practice of close breeding, and the inheritance by the progeny of tuberculous parents of what is usually regarded as a special aptitude to contract the disease.

2. *Close stabling*, which operates in two ways; by the unwholesome effect which the lack of sufficient ventilation produces on the constitution of the animals, cow stables of any size being almost always insufficiently ventilated; and

by the facilities which stabling offers for the spread of the disease by contagion. Contagion in this case generally takes place by inhalation of the dried discharges containing the virus.

3. The *contagium* now recognized as the exciting cause of the disease; this of itself, independent of other causes, will produce tuberculosis when artificially introduced into the system of many animal species including cattle, is constantly present in this disease and consequently is regarded as the essential factor in its production.

The introduction of one diseased animal into a herd of cattle especially of the improved breeds will, if undetected, almost certainly lead in time to a general infection of the herd which would often mean little less than ruin to the unfortunate owner. This is an event which may easily occur and shows the necessity of a careful inquiry by the purchaser into the health of the herd from which he intends to buy. It also shows the necessity of a thorough inspection of all herds of fine cattle in which there is any suspicion of the presence of this disease.

On the question of the intercommunication of tuberculosis between animals and mankind, the evidence so far accumulated points to the following conclusions:

1. Pulmonary tuberculosis of mankind, which in the adult is by far the most common form, has its cause, so far as contagion is concerned, in the inhalation of the germs contained in the dried sputa or expectorations of other similarly diseased human beings.

2. Abdominal tuberculosis of children may result from the use of the unsterilized milk from tuberculous cows when the latter are in an advanced stage of the disease or contain tubercular lesions in the udder. What proportion of infantile tuberculosis is due solely to this cause is uncertain.

3. An artificial tuberculosis has been produced in cattle by injection of the virus of human tuberculosis (Chauveau), and it is assumed that cattle may become infected naturally

by inhalation of the dried sputum of consumptive human beings ejected on the floor of cow stables, etc. How far this operates as a source of bovine tuberculosis has yet to be discovered, but it appears to be at least a possibility and naturally leads to the suggestion that consumptive persons would make very unsuitable attendants in a cow stable.

A brief description of the symptoms which might lead to a suspicion of the existence of tuberculosis is here given, but it should be said that in its early stage there is no disease more difficult of detection than this. It is indeed only when in one or more of a herd of cattle the disease has advanced to a late stage that its presence is usually suspected.

The disease is slow in its course, and at first unnoticed; many cases never show any symptoms and are only found to be tuberculous when slaughtered. One or more of a herd will usually be more severely affected and show some of the following symptoms:

Cough generally dry and hoarse, at first slight, occurring after drinking or feeding; it may easily be excited by making the animal run some distance. Unthrift, which is shown by a coarse or unhealthy appearance of the coat and falling off in condition. This persists in spite of good feed, and often progressively increases as the disease advances. The cough becomes more frequent and the breathing more rapid especially on slight exertion, the breath becomes offensive and occasionally there is discharge from the nose. There is no appreciable fever. Increasing weakness and the occurrence of disorders of digestion—occasional bloating of the stomach and diarrhœa—are often seen later, and the animal dies finally from exhaustion.

In the West and South where cattle are reared for the most part in the open air, the majority of infected animals are able in a measure to resist the more severe effects of the disease, and it is only occasional animals in the herd which show any symptoms of unhealth.

The *post-mortem* examination, which should always be made on any animal which dies or which has been slaughtered presenting the above symptoms, will generally enable even the inexperienced to recognize this disease if present. The changes are found in nearly all advanced cases in the lungs and the lymphatic glands in connection with them. The surface or substance of the lung will generally show solid cheese-like masses of varying size. A favorite situation for these tubercular masses is in the glands between and at the root of the lung. They may also be found in the abdominal organs.

Prevention.—Inasmuch as there is no profit in attempting treatment of cattle suffering from this complaint, but a manifest risk of greater loss from their continued existence, no words need be wasted on this subject. Its prevention is chiefly to be obtained by avoiding all risk of introducing diseased animals. When a herd of cattle has been found to be infected, even in an apparently slight degree, there is no method by which the disease can be eradicated except by the detection and removal of all diseased animals, and this can only be accomplished by the aid of tuberculin. Tuberculin, a material prepared from cultures of the specific germ of tuberculosis, when injected beneath the skin has the property of causing a rise of temperature in animals suffering from this disease, even in the most incipient stage, whilst sound animals do not show this reaction. It therefore supplies the veterinarian with a means of detecting all tuberculous cattle in an infected herd, and is the only means by which this can be accomplished. Tuberculin is now on sale by different firms in this country, and is offered free by the Department of Agriculture to those State sanitary or veterinary officials who are in a position to properly make and record the results of such tests. In order to obtain further data in the use of this agent, and to benefit the stock-raising interests of the State, examination of herds of cattle for tuberculosis will be made by this Department of the Experiment Station free of charge to those who desire it, in those cases in which there is reason to believe that such an examination is required. For the reasons already stated such an examination would, in general, only be required in the case of herds of fine stock, or in dairies of some size, in which there is reason to suspect the existence of the disease.

As the farmer or breeder is himself hardly capable of handling a disease of this kind, more precise directions are unnecessary here.

The following tables give the result of some recent tests of tuberculin as a diagnostic agent in tuberculosis made by this department on two herds of cattle, one of which proved free from disease and the other infected:

TESTS OF TUBERCULIN ON HERD OF HEALTHY CATTLE.—(A. I. U. Dairy.)

	No. 1. 10 Years 1,000 lbs. 2 cc.		No. 2. 5 Years, 850 lbs. 2 cc.		No. 3. 6 Years, 800 lbs. 2 cc.		No. 4. 5 Years, 700 lbs. 2 cc.		No. 5. 6 Years, 900 lbs. 2 cc.		No. 6. 5 Years, 800 lbs. 2 cc.		No. 7. 4 Years, 1,200 lbs. (Bull). 2.5 cc.		No. 8. 3 Months, 200 lbs. 0.5 cc.		No. 9. 2 Years, 600 lbs. 2 cc.		No. 10. 2 Years, 650 lbs. 2 cc.		No. 11. 12 Years, 700 lbs. 2 cc.	
	Before.	After.	Before.	After.	Before.	After.	Before.	After.	Before.	After.	Before.	After.	Before.	After.	Before.	After.	Before.	After.	Before.	After.	Before.	After.
A.M. 8	102.1	101.7	101.6	101.7	102.8	102.4	102.1	102.4	101.5	102.3	101.3	102.5	101.4	101.5	102.7	102.6	102.5	102.3	102.2	102.8	....	102.6
10	102	101.2	101.9	101.9	102.8	103.1	102 3	102.5	102.8	102.3	102.3	102.4	102.3	102.2	102	102.3	102.8	102.6	101.4	101.6	....	102
12	101.8	102.4	102.2	101.4	102.2	103.1	102.5	102.5	102.3	102.1	102.2	102.3	101.9	101.4	102.3	102.4	102.3	102.6	102.1	102.2	....	101.7
P.M. 2	102.4	102.1	101.8	101.4	102.6	103.2	102.1	102.2	102	102	102 4	102.2	102	102.5	102	102.1	102.4	102.2	102.8	102.9	......	101.4
4	101.8	102.2	99.8	100.6	100.8	101.2	100.1	101.6	102	101.8	101	101.6	101.8	101.5	101.9	102	101.6	101.5	102.1	102.9	....	102.5
6	102 4	101.3	101.4	101.5	101.7	102.1	101.7	102	102.2	102.4	102.5	102.2	102.1	101.8	102.1	102.8	102.1	102.5	102.6	103.2	....	103.2
10	102.1	....	100.2	....	102.1	....	101.4	....	101.6	....	101.7	....	101.4	....	102.6	....	101.8	....	202.7	....	103	....

Injection made at 10 p. m. February 19. Vertical columns headed "Before" and "After" show the temperature of each cow at the same hour on the day of injection and on the day following. It will be seen that in no case was there any thermal reaction which could excite a suspicion of tuberculosis. The table also shows the variations of temperature which may be found in healthy cattle from natural causes.

Tests of Tuberculin on Part of Herd of Cattle Affected with Tuberculosis.

	No. 1. 1 Year, 400 lbs. 1 3 cc.	**No. 2.** 6 Years, 550 lbs. 1.5 cc.	**No. 3.** 7 Years, 1,000 lbs. 2 cc.	**No. 4.** 7 Years, 1,000 lbs. 2 cc.	**No. 5.** 7 Years, 1,000 lbs. 2 cc.	**No. 6.** 7 Years, 600 lbs. 2 cc.	**No. 7.** 4 Years, 500 lbs. 2 cc.
P. M.							
10	104	102.8	104	102.8	102.8	101.7	102.5
A. M.							
9	102.5	107	102.5	105.2	106.5	105.8	101
11	102.2	105.2	102.5	105.2	106.4	105.8	100.8

INJECTION OF TUBERCULIN MADE AT 10 P. M. FEBRUARY 7.

First horizontal column shows temperature just before injection, the next two at times indicated, on following morning.

The high temperature of Nos. 1 and 3 at time of injection was no doubt due to excitement induced by unaccustomed stabling.

A thermal reaction indicating tuberculosis is shown in the columns representing Nos. 2, 4, 5 and 6.

No. 7 was in last stage of disease and did not react. It died two days later. The autopsy made on this animal and No. 6 showed extensive tuberculosis of lung. No opportunity was afforded for making *post mortem* examination of the others.

Glanders in Horses and Mules.

From time to time requests are received for information as to the methods to be adopted for the suppression of this disease. This information has already been given in a previous report, but as the supply of this is exhausted a brief summary of the symptoms and preventive measures is here reproduced.

Symptoms—The disease is most frequently seen in the chronic form; there is a discharge from the nostrils which varies in appearance and cannot be considered as characteristic; it may either sink in water or float on the surface; usually it is somewhat viscid and adheres around the edges of the nostrils, may be thin and almost clear and small in amount, or thicker and yellowish, with or without odor. The discharge is not so abundant as in distemper, but often differs little from that which occurs in other catarrhal conditions of the lining membrane of the facial sinuses. Hence chronic glanders is often confounded with chronic catarrh. The most characteristic symptom of glanders is the occurrence of ulcers on the partition between the nostrils, but these are absent in perhaps the majority of cases, or situated so far up as to be removed from sight. The lymph glands situated just within the bones of the lower jaw become enlarged, hardened and drawn up close to the bone. There is sometimes slight discharge from one eye. Discharge from the nose and enlargement of the inter-maxillary glands are nearly always present, but in many cases there may be, for a long time, no other symptoms presented and such cases cannot be diagnosed by mere physical examination even by the expert. When a number of horses in a stable become infected some will probably show the disease in a severe form. The further symptoms by which glanders declares itself are those which occur when the disease becomes acute or takes the form known as farcy. In acute glanders the course is more rapid, with fever, greater discharge from the nose often streaked with blood, and sudden swelling of one or more limbs. Ulcers soon appear on the lining membrane of the nose. Death is the common termination, but in some cases the acute is followed by the chronic form. The lesions in the skin, which may arise in the course of either chronic or acute glanders presenting the above symptoms, or in some cases may exist as the only visible symptoms, are small nodular enlargements of the size of a bean or larger which form in different parts of the body but most frequently along the course of the vessels inside the limbs or on the face or neck. There is later an appearance as of hard cords running in each direction from these enlargements. Only a few may be present at one time or they may be numerous. They ultimately burst and discharge a thin, yellowish, viscid material; after a time they may heal up but are generally replaced by others. "Farcy," the name by which this form is known, may be very chronic in its course and apparently subside, all the symptoms disappearing for a time, or the symptoms of acute glanders may supervene. Both forms of the disease are alike incurable and dangerous to other animals.

Treatment—As in the case of tuberculosis of cattle just described, preventive and not curative treatment is what is required. Although it appears probable that in both of these diseases occasional cases of complete recovery may take place and this result be assisted by appropriate treatment, such cases are very rare. A more frequent occurrence in both cases is that the disease under favorable circumstances may become latent, the animal appear to have recovered, but still contain tubercular or glanderous lesions in the lungs or lymph glands which may at any time again take on a more acute form. Even during the period of apparent latency such animals are usually a source of danger to others. Glandered horses, therefore, wherever there are proper sanitary laws, are condemned to slaughter either with or without compensation to the owner. Some such law also exists in this State, but the owner of glandered horses will best consult his own interests by not waiting for its enforcement.

Where the symptoms are so plain as to obviate any doubt as to the diagnosis the diseased animal should be killed and buried deeply; every animal which has been in contact with it should be carefully watched for some weeks or even months. If the symptoms are less plain and the diagnosis doubtful the suspected animals should be isolated, that is, kept apart from others, until the disease either develops further or recovery takes place. In all such cases veterinary advice should be secured whenever it is available. The contagion of glanders is contained chiefly in the discharge from the nose and in the case of the form called farcy in the discharge from the ulcerating nodules in the skin, and this contagion is capable of retaining its vitality for an uncertain length of time—one month at least and probably under favorable conditions much longer—in the dried state on the mangers, racks, and other articles which may have been in contact with it, consequently all such articles should be thoroughly disinfected. Stables should be well cleaned out, loose hay and bedding burned, mangers and racks scraped or washed clean and disinfected with a solution of corrosive sublimate in the strength of about one to a thousand (1 drachm corrosive sublimate, and 1 ounce common salt, dissolved with the aid of heat in 1 gallon rain water; larger quantities in the same proportion; this solution, it should be remembered, is highly poisonous). A 2 per cent solution of crude carbolic acid can also be used. Neither of these solutions should be handled more than necessary with the naked hands. A coat of whitewash, containing chloride of lime, to the walls and woodwork of the stable is also a desirable application. Harness, brushes, combs, etc., also have to be disinfected or burned.

A very important point to remember in connection with glanders is that the discharges from diseased horses are also dangerous for human beings when applied to an abraded surface. Persons with sores or cuts on the hands should, therefore, be careful to avoid contact with the discharge. A stable which has contained glandered horses should be left vacant after disinfection for at least three months, and six months would be safer.

A certain diagnosis of glanders is obtained by the veterinarian in a similar manner as with tuberculosis in cattle, namely, by the injection of the products of the growth of the glanders bacillus known as *mallein*.

In all outbreaks of glanders of any magnitude the veterinary department of the Experiment Station will make the necessary investigations and give further directions as to its treatment.

R. R. DINWIDDIE.

CONTENTS.

PAGE

Hay and Pasture Plants 160
Soil and Climatic Divisions of the State 160
Hay and Pasture Plants for Different Soils 161

GENERAL REMARKS:

Preparation of the Soil, Manures 167
Sowing the Seed 168
Management of Meadows and Pastures 170

GRASSES FOR ARKANSAS SOILS:

Orchard Grass 171
Red Top 172
Hungarian Brome Grass 172
Rescue Grass 172
Timothy 173
Bermuda Grass 173
Kentucky Blue Grass 174
Tall Fescue 175
Tall Meadow Oat Grass 175
Johnson Grass 175
Teosinte 176

LEGUMINOUS PLANTS:

Cowpea 176
Red Clover 177
Crimson Clover 177
Alsike Clover 177
Melilotus Alba 178
Alfalfa, Lucern 178
Japan Clover 179
Burr Clover 179

The illustrations used in this bulletin were furnished the station by the Division of Records and Editing of the Department of Agriculture.

Hay and Pasture Plants.

It has been the custom of farmers of the State, especially cotton farmers, to grow only a small part of the hay that their farms required. The extra hay that has been necessary for the farm as well as that used in the cities has been imported. The imported hay is usually an inferior quality of timothy or prairie hay. The production of hay in the State is, however, increasing and there is no reason why the increase should not continue until all the farms and towns in the State are supplied with home-grown hay. The profitableness of such a change in the system of farming in the State does not require proof. While the cotton farmer is now considering crops for diversification he should not overlook the one for the production of hay, at least to the extent of supplying his own farm with good hay. An abundance of hay and pasture means more and better live stock of all kinds and that means more food supplies, more manure, better lands, less dependence upon the merchants and more prosperity and independence for the farmer. While hay is not produced in the State to the extent that it should be, neither is the importance and value of pastures fully appreciated. The favorable climate permits permanent pastures to be made that will furnish grazing throughout the year and there is much land left idle on many farms that would be profitable if put in pasture and that would also be improved in fertility.

Soil and Climatic Divisions of the State influence very much the growth of grasses and clovers. In northwest Arkansas hay has always been produced to quite a considerable extent. In that section the soil is clay and clay-loam and contains more or less lime. The summers are not so hot and long, hence the soil and climate are very favorable to grass. In east and south Arkansas these conditions are changed. The soil is sandy loam and alluvial bottoms. On the latter grasses and clovers grow well, as moisture and fertility are favorable, but on the uplands only a few grasses grow successfully. The farmers in those sections have never given much attention to either meadows or pastures and consequently are mainly but little acquainted with their management. Those sections until recently imported almost entirely all the hay used on the farms and in the towns.

Hay and Pasture Plants for Different Soils.

As all grasses and clovers are not suited alike for the same soil and locality, selection must be made with reference to the particular soil that is to be sown. The soils of the State may be divided in a general way into 1st, alluvial or bottom lands, 2d, uplands. The uplands can be divided into 1st, sandy loam with clay subsoil, which is the character of most of the uplands in east and south Arkansas; 2d, clay loam and fine sandy loam with clay subsoil near the surface. This is mainly the character of the soil in northwest Arkansas. The sand of south Arkansas is coarser than that of east or northwest Arkansas.

(1) Alluvial or bottom land of east and south Arkansas.

(2) Sandy loam or upland soil of east and south Arkansas.

(3) Valley soils of northwest Arkansas.

(4) Clay loam and sandy loam or upland of northwest Arkansas.

On account of the difference of the soil in the east and south part of the State from that in the northwestern part it will be best to mention separately the grasses that can be grown successfully on the soils of the two sections. This will be done from trials of various grasses and clovers that have been in progress for the last five years at the northeast substation and for a shorter time at both the main station and the southern substation. These trials show very clearly the grasses that can be grown on the different soils.

In selecting soil for meadows and pastures the suggestion is made, that meadows be made on the best soil of the farm and the lowlands where fertile, as they usually are, should be used instead of the uplands, because moisture is more abundant in them than in the uplands and therefore an annual crop of hay is more certain; that pastures can be made on poorer soils than meadows and the poor soils of the farm should be used for pastures. They would be more profitable in pastures than in cultivated crops and would be improved at the same time.

1. *Alluvial or Bottom Land*—In east and south Arkansas there is much alluvial soil along the streams that is very fertile and plants growing upon it do not suffer so much during drouth as they do on the upland. This should be used for permanent meadows instead of the upland.

Permanent meadows—On this class of soil orchard grass and red clover make an excellent single or mixed meadow. Both of these plants permit grazing. Alfalfa produces a large yield of hay when the subsoil is well drained. Bermuda and Johnson grass both succeed and make an abundance of superior hay. Red top would be advisable to plant wherever the soil is wet. It will stand water longer without injury than the others. Orchard grass, red clover, alfalfa and red top are all well known grasses and sell without prejudice, but

Johnson grass would not sell so readily. Tall meadow oat grass can be sown with orchard grass to a good advantage.

Temporary meadows—Red clover and crimson clover are successful for temporary meadows. They would serve a double purpose; produce hay and improve the soil at the same time. Melilotus alba yields well and makes good hay if cut before it gets hard. On bottom lands that are not so very fertile Japan clover is excellent for temporary meadows.

2. *Sandy Loam or Uplands*—On this class of soil permanent pastures are usually made. The upland soils are to be found in various stages of fertility and upon the fertility will depend the selection and success of the grasses for meadows. If the soil is poor there is no use to try to make a meadow of it until manures have been heavily applied, as no grass will make hay on poor soils.

For permanent meadows orchard grass, tall meadow oat grass and red clover do well mixed as they ripen near the same time. Alfalfa succeeds where the soil is sufficiently fertile, but little hay need be expected from it the first year on this soil.

Tall oat grass is good on uplands and can be grown with orchard grass and like orchard grass endures drouth well. Bermuda grass is excellent, though the soil must be fertile for it to get high enough for hay.

In view of the fact that little of this class of soil is fertile enough to make good hay from grasses, permanent meadows on them are not, therefore, as advisable as temporary ones in which the legumes, that is, clovers or cowpeas, are used.

For temporary meadows and for renovating, Japan clover, crimson clover, red clover and cowpeas are good, especially the latter. The cowpea does not require a fertile soil to make a good crop of superior hay, neither does it suffer to any extent from drouth. For temporary meadows on all upland soil that is not fertile the cowpea is superior to anything else. On rich upland red clover is best, and when the land is wanted for cotton, corn, or other crops the same season, crimson clover is best. Rescue grass can be sown for early hay and cowpeas sown after it for hay.

Pastures—In making a temporary pasture for only one or two years the clovers should be used. It is not profitable to sow grasses for pastures unless the pasture is to remain for a greater period than two years. The poorest soil of the farm, especially where land is abundant, is no doubt the best to put in pasture, but it must be remembered that poor barren soils will not make good grass pastures, though pastures, whether grass or clover, can be made on poorer soils than meadows can. If the soil be too poor to bring grasses for permanent pasture it can be quickly improved by sowing Japan clover and grazing it for two or three years; then plant and turn under a crop of cowpeas and sow the grasses and clovers that are to form the pasture mixture. Japan clover need not precede the cowpeas if the soil is not very poor. All permanent pastures should be sown with mixed grasses for the reason that mixed grasses ripen at different seasons and grazing will be furnished throughout the year. Hungarian Brome grass, tall meadow oat grass, tall fescue, orchard grass and red clover form a good mixture that ripens at different dates. If the soil is not fertile, tall fescue and red clover will not succeed and should not be planted. Bermuda grass is the best summer grass for this soil, but there is no other plant that is commonly sown with it to furnish grazing in winter and early spring. Burr clover is said to do it successfully. It can be sown every fall if no seed matures, by first scarifying the Bermuda sod with a good harrow. Scarifying should be done every fall to get the clover seed in the ground. Crimson clover on fertile soil makes good winter and spring grazing. It should be sown in August or early in September if the season will permit. One of the best plans for hay and winter pasture on poor uplands is to sow rescue grass and cowpeas. The rescue will come up in the fall and grow for grazing during winter and reseed in early spring. Cowpeas may then be planted and they will come off in time for the rescue to grow again during the succeeding winter. This process can be continued as long as desired. The pea roots fertilize the rescue. This combination furnishes abundant rich cowpea hay and excellent grazing in the winter and spring. The only objection to this plan is that the rescue may not, on account of soil or season, begin much growth until late in winter or early spring. With us it has grown off early each season. The seed should be sown in August or early in September if the season will permit. When grazed closely on good soil its roots are said to be perennial.

3. *Valley Soils of Northwest Arkansas.*

Permanent meadows—The soils of the valleys are more moist and fertile than the upland soils and are therefore better for permanent meadows. For this class of soil orchard grass and red clover mixed are the best grasses for meadows. On good soil orchard grass yields heavily and when spring rains are frequent three cuttings can be made in one season. It is much superior to timothy as a hay and pasture plant, though timothy is more largely grown at the present time. Alfalfa yields largely of hay where the soil is good and when properly sown and cared for the first year. Melilotus does well for hay. Tall oat grass succeeds and resists drouth well on this soil and is good to mix with orchard grass and red clover. When the soil is too wet along streams for the other grasses red top should be sown. Alsike clover succeeds well in pasture or meadows.

Temporary meadows—The clovers are best and where the soil is wanted for another crop the same year crimson clover should be sown. Rescue is a good annual hay grass on this soil and can be followed by cowpeas for hay or manure.

Pastures—Permanent. Orchard grass, red top, tall oat grass, tall fescue, Hungarian brome, alsike clover and red clover form an excellent mixture that affords grazing throughout the year. Orchard grass, tall meadow oat grass and brome grass are best in spring and summer and tall fescue, alsike clover and brome grass in winter. Kentucky blue grass does well in pasture mixtures on good soil.

For temporary pastures the clovers of course should be used. Rescue grass and crimson clover make excellent annual winter and spring pastures.

4. *Clay and Sandy Loam or Upland Soil of Northwest Arkansas*—The grasses mentioned for meadows and pastures on the valley soils are suitable to the upland soils for the same purposes.

Prairie Lands.

On the prairie lands in the eastern and southern parts of the State I have not tried any grasses and cannot recommend any as sure of success, but from the nature of the soil where the subsoil is not too wet a few grasses can be suggested as being likely to succeed best for hay. Melilotus alba, red clover, Japan clover, and probably orchard grass.

Bermuda, burr clover, Alsike clover and Hungarian brome would no doubt make good pastures.

General Remarks.

The question is frequently asked, what are some good grasses for fall, winter and early spring pasture? The annuals that are good are burr clover, rye, rescue and crimson clover. Rye is more susceptible to cold than rescue grass. Crimson clover requires better soil than rescue grass. The perennials that are good for winter pasture have been mentioned in the preceding pages.

Millet and oats make excellent hay to be followed by cowpeas for either hay or manure. Millet is the best plant for hay on the annual overflow bottom lands that remain wet very late.

The favorable climate and the uncultivated soils of the State permit very good natural pasturage and meadows. Excellent hay can usually be made of crab grass and other native grasses that cost only the cutting, but they are too uncertain to be relied on exclusively for hay. Japan clover, crab grass and other native grasses form good meadows and pastures and if given some attention they would be more profitable and permanent.

Preparation of Soil for Sowing Meadows and Pastures.

Soil can be put in the best condition when sown in cowpeas and the vines turned under. The peas improve the physical condition of the soil and subsoil and leave plant food for the grass. On the northeast substation two plats were sown at the same time. One plat had turned pea stubble and the other was without stubble. The stand and growth of grass on the pea stubble plat was excellent while that on the other plats was very much inferior. Red clover has more than doubled its growth on soil where cowpea stubble alone was turned under. If the soil is fertile there is no necessity to turn under a crop of cowpeas before sowing grass. The best manures for grasses are nitrogenous vegetable matter such as pea vines and stable manure. On the northeast substation mineral manures have made no perceptible increase in growth of grasses but pea vines and stable manure wherever used made a marked increase. These trials show that the worn sandy cotton soils must be improved with vegetable matter before grass can be successfully grown. Mineral manures have increased the growth of clovers and cowpeas, but the increase of clovers has been greater where mineral manures were first used on cowpeas and the vines turned under. When stable manure is not convenient to fertilize a meadow sufficiently pea vines can be aided to an increased growth with mineral manures. Pea vines and stable manure, besides furnishing plant food, retain moisture in the soil and improve the soil's condition. Meadows to be kept up to a profitable yield of hay must be frequently top-dressed with manures. If this is not done the meadow will decline and wild grasses and weeds will soon take possession.

The soil and subsoil should be thoroughly broken so as to increase their water-holding capacity and to give the roots suitable conditions for growing and a larger territory to grow in. The soil should also be made firm and even in texture by harrowing and rolling. The harrowing is important because the soil must be finely pulverized so that the small grass seed may germinate and grow. The depth of covering grass seed depends on the size of the seed. A roller should be used to compact the soil over the seed to retain moisture around them.

Sowing the Seed.

Testing seed—Before sowing grass seed it is always advisable to test it to ascertain the per cent of good seed.

The process is simple and easy. Measure or weigh out a very small quantity of seed and put them between folds of cotton cloth. Allow the ends of the cloth to extend into a vessel of water and support the part with the seed above the water. Place the apparatus in a warm room and see that water is kept in the vessel. After a few days the good seed will have germinated and an estimate can be made of them.

Time to sow grasses depends upon the character of soil, its fertility, presence of moisture and the kind of grass or clover. The best time to sow is early in September provided a good rainfall has wet the soil sufficiently for it to remain moist until after the seed, which should be planted as soon as the rain falls, has germinated and made some root growth. The advantages of early fall sowing are to secure a good growth which will endure winter freezes, which will resist the first summer drouth, and which will have made a good growth by spring and thereby be in advance of noxious vegetation and possibly furnish one mowing the first year. But owing to the light rainfalls in summer and fall it is extremely hazardous to sow either grasses or clover at that season unless the soil is sufficiently moist at the time of sowing. Sowing in February or the first of March is more favorable for securing a good stand, but owing to the alternate periods of heat and cold in northwest Arkansas clover should be delayed to the 1st of March to insure a good stand. Better success has attended the February sowing at the northeast substation than has attended planting at other seasons, except when moisture was sufficient in September.

Sowing grain with grass and clover for protection to the young plants is no longer practiced or advised by the best authorities.

Management of Meadows and Pastures.

A correct understanding of the management of grasses and clovers in pastures and meadows is necessary to avoid failure, especially in east and south Arkansas. In northwest Arkansas the difficulties of success are much less than in other parts of the State, but even in that section more care and attention on many meadows and pastures would be more profitable.

In sowing meadows and pastures it is advisable, especially if the hay is to be used on the farm, to sow mixed grasses and clovers rather than one single kind. In mixed meadows the kinds should be selected that ripen at the same time, while in permanent pastures plants are selected that do not ripen at the same time. It is important to sow clovers with grasses in pastures, mainly because the clovers aid in maintaining the grasses and improve the soil. The clover roots decay and furnish to the grasses nitrogen secured from the air and potash and phosphoric acid secured from the subsoil. This is of equal importance in meadows where the hay is to be used on the farm, but if it is to be sold many purchasers object to clover being mixed with grass hay. Mixed grasses and clovers occupy the soil more economically, give a better variety to the hay or grazing than single grasses or clovers and produce more hay and pasturage. Mixed meadows and pastures are also less liable to fail in a dry season.

Meadows should not be mowed too close during a spell of hot, dry weather, because the sudden exposure of the roots to the sun would be very harmful.

The grazing of meadows depends upon the character of soil and the kinds of grasses. If the soil be very heavy clay, grazing is harmful to the soil, but if sandy, trampling is beneficial to it.

When grazing meadows the aftermath should not be grazed too close for fear of injury from freezing, but the grazing off of some of the aftermath is beneficial, because new growth in spring begins much earlier.

Time to cut for hay depends upon the variety of grass or clover and various other conditions, but *ordinarily* grasses should be cut while in full bloom and not later than the blooms begin to fade. Should mowing be delayed later than that stage much of the hay becomes woody and the second cutting is shortened and delayed.

Grasses.

Thirty-five of the supposed best agricultural grasses were planted at the northeast substation and after three years all were discarded except the best and most promising ones. These have been continued five years since planting and are discussed in detail below.

Orchard Grass.

ORCHARD GRASS (*Dactylis glomerata*) has succeeded much the best of any grass that we have tried for hay and pasture on the clay soils of northwest Arkansas, and on the bottom lands of east and south Arkansas. On the lighter sandy uplands it has not done so well. The summer drouths affect it but little and as soon as rains occur it begins rapid growth. It is almost evergreen, making excellent pasture in winter and early spring and is ready to cut for hay early in May. Bulletin No. 29 contains a full discussion of a trial of orchard grass and timothy on clay loam soils in the northwest part of the State, and the reader is referred to that bulletin for a comparison of the two grasses. Red clover is an excellent legume to mix with orchard grass. It ripens at the same time and occupies the spaces between the clumps of orchard grass. Orchard grass yields abundant hay on good soil and should supplant timothy as the hay plant of the State. It is easily seeded, 30 to 40 pounds seed per acre are required. Thick seeding prevents the grass from growing in clumps.

RED TOP (*Agrostis alba*) does not succeed on uplands but is excellent on moist lowlands for hay. It will grow on soil too wet for the other common grasses and is an excellent grass for mixed pastures on those lands. It starts rather late in spring and flowers late; 20 to 25 pounds of seed are required per acre when sown alone.

Hungarian Brome Grass.

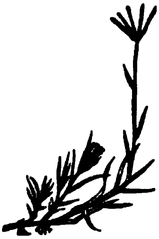
HUNGARIAN BROME GRASS (*Bromus inermis*) is a perennial grass that is as yet but little known in the State. It endures summer drouth extremely well and grows well during winter. It is one of the very best all the year pasture grasses for dry, poor uplands. It is almost evergreen. The leaves are long, numerous and tender, hence well adapted to grazing, but not so well adapted for hay; 40 to 50 pounds of seed per acre is advised for sowing to get a good stand.

RESCUE GRASS (*Bromus unioloides*)—This grass is an annual but when grazed close on good soil its roots are said to become perennial. It does not bear heat and drouth very well so ripens its seed in early spring then disappears until fall when the seed come up and the grass grows and remains green all winter, being unaffected by cold. It is an excellent hay and pasture grass and on good soil during favorable seasons a cutting of hay can be made and the second growth will mature seed. On the sandy soil at Newport and Camden it seeded from 10 to 15 inches high, and at Fayetteville, on a little better soil, 24 inches high. With us it has started a good growth each fall but it is reported as being uncertain sometimes in this respect. The occupation of the soil during fall and winter with this grass and with cowpeas in summer is an excellent plan. Rescue grows upright and is not so leafy as the Hungarian brome to which it is closely related. The seed should be sown early in September at the rate of 30 to 40 pounds per acre.

Rescue Grass.

TIMOTHY (*Phleum pratense*)—After repeated planting this grass has been a complete failure at the two substations and also a failure, though not quite such a bad one, at Fayetteville. It is a very shallow rooted grass and fails completely or dries out on light soil during dry summer. On the best clay soils of northwest Arkansas and the best bottom lands of east Arkansas it grows very well but disappears there after three or four years. On such favorable situations orchard grass would far excel it in yield of hay and permanency. Timothy, however, has such a firm place in the estimation of farmers and those who buy hay that its production is continued notwithstanding its undesirable qualities.

BERMUDA GRASS (*Cynodon dactylon*) is the best summer pasture grass we have for the sandy soils of south Arkansas and is one of the best hay grasses for all parts of the State except the northwestern part. It is not generally regarded with much favor but where it has established itself and is being utilized it is regarded with great favor. On barren soils it does not succeed, but it succeeds on all other soils whether wet or dry. It makes hay of superior quality that is highly relished by live-stock. When the value of Bermuda for hay, pasture and a soil renovator are appreciated and the proper methods for cultivating and controlling it are understood, it will be a highly appreciated grass. At the present time, however, it is seriously objected to because of the difficulty of eradicating it. That difficulty is not by any means so great as many suppose. In Bulletin No. 28 the results of different methods of eradicating it are discussed. Shade is fatal to the grass and by using the harrow, then oats, then cowpeas and cotton the grass can be subdued and eradicated. To start the grass by seed is uncertain. The cheapest and best way to start it is to turn up a Bermuda sod and harrow the roots into piles, then chop them into short pieces with a hatchet and sow them on freshly broken soil and plow them in. The roots must not get dry while out of the ground.


Bermuda Grass.

KENTUCKY BLUE GRASS (*Poa pratensis*)—On the uplands of east and south Arkansas this grass does not succeed, but on good clay uplands and valleys of northwest Arkansas it succeeds very well in pastures and lawns.' On the moist, fertile bottom lands of east Arkansas it succeeds but not sufficiently for hay, and those soils are too valuable for pastures. It makes little growth the first year from seed but improves with age. This grass is of considerable value in pastures in the northwest part of the State; 30 to 40 pounds of good seed are usually sown per acre.

Kentucky Blue Grass.

TALL FESCUE (*Festuca elatior*) is a perennial grass of much value for winter pastures on good soils especially in mixtures. On light sandy loams it is not successful. It roots deeply, is little affected by drouth and is unaffected by cold. This grass should not be sown on very poor upland soils for pastures in south and east Arkansas because it will not succeed, but on good clay soil of northwest Arkansas it is a valuable grass for mixed pastures. It is sown alone at the rate of 35 pounds per acre.

TALL MEADOW OAT GRASS (*Arrhenatherum avenaceum*) is an excellent hay and pasture grass for the dry uplands of the State. It stands drouth extremely well and grows well during winter and early spring. It ripens early, about the same time as orchard grass. The stems grow tall and leafy but not coarse. This grass is one of the best pasture grasses we have and is almost evergreen. It is perennial. The seed are large and 30 to 40 pounds are sown per acre.

JOHNSON GRASS (*Sorghum halepense*)—This is a strong cane-like rooted perennial grass and is one of the most valuable hay grasses for the South and at the same time it is the most difficult to eradicate or exterminate. The grass is easily propagated from seeds and on the rich bottom lands it will yield more good hay than any other grass. No one, however, is advised to sow this grass if the *soil is ever to be wanted for other crops*, but on the lowlands in east Arkansas that are wet in early spring and that cannot be used profitably for other crops this grass is the thing to plant. The hay is harmless in so far as scattering the seed is concerned if the grass is cut when in bloom, and

Johnson Grass.

that is the best time to cut it to make the best hay. If the land is turned out and cattle and hogs allowed free access to it, it is possible for them to kill out the grass after a few years. When sowing it, 60 to 70 pounds of seed are put to the acre.

TEOSINTE (*Euchlæna luxurians*) — This plant is a tall growing, tender annual, closely resembling corn. It requires rich, moist soil, and a long season. The seasons are not long enough in this latitude for it to make seed. It is a heavy forage plant, growing very high and tillering enormously. On suitable soil the yield of forage is enormous. It is cultivated like corn, and about five pounds of seed are planted per acre.

Teosinte.

Leguminous Plants.

COWPEA (*Dolichos sinensis*)—This plant is used more extensively for hay in east and south Arkansas than any other plant. The increase in its cultivation during the past three or four years has been most rapid. On the thin uplands of those sections there is no other plant equal to the Cowpea for hay, besides improving the soil at the same time. With the use of the stack-frame devised by the station for curing the vines there remains no obstacle in the way of the extensive use of this plant for hay in all parts of the State. The cultivation of this plant has been so fully discussed in other bulletins of this station that it is not necessary to enter into the details again. It is by far the best plant for hay on the worn cotton soils of the State, but where the soils are fertile red clover can be handled to a better advantage.

RED CLOVER (*Trifolium pratense*) is well adapted to all soils of the State, except the worn, upland cotton soils, and is more largely grown in northwest Arkansas on the clay soils than elsewhere in the State. Red clover is well known, but it is not as generally cultivated as its merits warrant it to be.

CRIMSON CLOVER (*Trifolium incarnatum*)—This clover is but little known in this State. It is an annual, and on good soil produces good hay, and also good fall, winter and spring pasture. It flowers earlier than red clover. At Fayetteville it grew about 18 to 20 inches high on thin clay soil. On sandy soils it will not succeed, but on good soils it is an excellent temporary hay and pasture plant. The seed should be sown the first of September, or as early as the season will permit. If allowed to reseed in the spring it will come again in the fall, even if the soil is occupied during summer by a short growing crop. About 15 pounds of seed are sown per acre. Potash applied to crimson clover on most poor soil will cause a good growth.

Crimson Clover.

ALSIKE CLOVER (*Trifolium hybridum*)—This clover is a perennial, and succeeds best on fertile lowlands, and on soils too wet for other clovers. On such soil it makes an excellent hay and pasture. Only extreme cold affects it, and therefore it affords good winter grazing. For mixed meadows on rich bottom lands in east and south Arkansas it is the best clover to sow. It grows much better on uplands than is generally supposed, and appears to suffer but little more, if any more, than red clover does during drouth. It acted in this manner on the northeast substation. Ten pounds of seed are sown per acre.

Melilotus Alba.

MELILOTUS ALBA, commonly called Bokhara clover—This plant makes seed the second year, then dies, and its roots, which have penetrated deeply into the soil, rapidly decay. It has succeeded with us on sandy loam soil of moderate fertility, and on clay loams of like fertility, though lime soil is best suited to it. When sown on rich bottom lands it grows luxuriantly and makes several cuttings of hay. It should be cut for hay before the stems grow hard and woody. Its deep roots enable it to resist drouth. It is a most important renovating crop, especially for lime soils. The plant resembles alfalfa, though much coarser. It comes readily from seed, which are sown at the rate of 15 pounds per acre.

ALFALFA, LUCERN (*Medicago sativa*)—This plant lasts indefinitely on suitable soil. The more fertile the soil and subsoil the better it grows. On thin, sandy soil with poor subsoil it is not a success. The subsoil must be well drained, as the plant roots very deeply. Unless the soil is fertile its growth is somewhat slow the first year, and must be protected from rank weeds. A good way to start it on thin soil is to sow it in narrow fertilized rows, cultivate the first year and let it make seed. The seed will come up in the middles the next year and make a solid stand. When well set on good soils it yields abundantly of excellent hay and every farmer should grow it. The plant is a most excellent soiling plant, beginning an early growth, continuing late and affording many cuttings. To make good hay it must be cut before the stems get hard. It is very good in mixed pastures on bottom land. If seasons will permit, early in September is the best time to sow the seed. They are sown at the rate of 20 to 25 pounds per acre.

JAPAN CLOVER (*Lespedeza striata*)—This plant is an annual and has, from an introduction into South Carolina from Japan, spread all over the South. It makes a better growth than any other plant on poor, barren, clay soils. Its hay is highly nutritious and when sown on good soil, especially bottom soil, it grows from 20 to 30 inches high. Its greatest value in the State is for pastures on poor soils and for fertilizing such soils. It quickly takes possession of uncultivated fields and holds them from washing, and protects them from the hot sun. The plant prefers clay to sandy soil. It furnishes grazing from middle of May until frost kills it down. Seed are sown in early spring at the rate of 15 pounds per acre.

BURR CLOVER (*Medicago maculata*)—This is an annual plant that grows in fall, winter and spring, and is only valuable for pasturage in those seasons. It is not specially liked by stock, but in absence of other green food in winter it is eaten quite readily. Good soil is necessary for best results. The plant is of most importance to south and east Arkansas for sowing on Bermuda sod, for winter pastures. It reseeds itself before Bermuda commences growing in spring. By thus using these two plants continuous pasturage can be had throughout the year. The seed should be sown in early fall at the rate of 15 pounds per acre.

R. L. BENNETT.

Composition of Some of the Syrups Sold in Arkansas.

One of the first steps toward progress in any extensive agricultural community is the production at home of as great a proportion as possible of the necessaries of life. Syrup* is a staple article of food and may be looked upon as one of the necessities. The remarkable adaptability of this State for the production of that article from sorghum and the fact that the southern part of the State is well suited to the making of syrups from sugar cane have made it apparent that anything which can be done to encourage the production and consumption of home made syrups is worthy of special attention.

With the above end in view a collection of syrups sold in the State has been made for the purpose of making a chemical examination of them in such a way as possibly to show something of their relative values.

The syrups commonly sold in the markets may be divided according to the material from which they are manufactured, into four principal classes:

1. *Sugar Cane Syrup.* Sugar cane was originally the source of what is commonly known as New Orleans molasses. At the present time much of what is commonly sold under

---

*The term *syrup* as used in this bulletin includes all articles for table use commonly sold under the names of syrup or molasses. Dr. Wiley (Page 710, Part 6, Bul. 13, Div. of Chem., U. S. Dep. of Agr.) distinguishes between the two as follows: "Molasses is the natural product of the manufacture of sugar cane, sorghum or maple sap, or any product from which part of the sugar has been removed. Syrup is the product of the refining of these articles or the mixing of various other articles together."

that name is a mixture of sugar cane syrup with varying proportions of glucose or some other adulterant.

2. *Maple Syrup.* When pure this article is the concentrated juice of the hard maple. Some samples of it were collected in the State, the purity of which could not be questioned. Another sample was examined which probably contained nothing which ever came from a maple tree. The result of the analysis of this sample is not given in the subjoined table.

3. *Sorghum Syrup.* This article is too well known to need further introduction.

4 *Glucose Syrups.* Syrups of this class are artificially manufactured from starch. When carefully prepared they are probably as harmless as any syrup, but they are also of less value because their sweetening power is small. The lack of sweetening power is due to two causes: (1) glucose syrup always contains a considerable proportion of dextrin, an article which is practically tasteless; (2) grape sugar, which constitutes a considerable proportion of the two sugars found in glucose, is in itself much less sweet than cane sugar or the common sugar of the grocery.

Instead of being sold in its pure condition glucose syrup is more commonly mixed with other syrups and sold under the name of those syrups or under some fancy name which may be more or less misleading as to the true source of the article purchased. Such a syrup is "Sugar Loaf Syrup," numbered 18 in the table. The common trade name of glucose syrup is corn syrup. Of twenty-six samples of syrup examined eleven were found to consist wholly or in part of glucose. These syrups were selected without reference to their probable adulteration and it seems likely that they will represent pretty fairly the average character of syrups sold in the State.

For the purpose of ready comparison a table has been prepared showing the composition of the syrups examined. These syrups were collected in the markets of Newport and Fayetteville. Those from Newport were obtained by Mr. G. B. Irby and of these the wholesale price is given. Of those collected in Fayetteville the retail price is given. All were gathered and analyzed in the spring of 1895.

Generally speaking, syrups contain the following materials: A quantity of water; sugars of two or more kinds; a quantity of mineral matter or ash; and some other impurities. Of the other impurities in glucose syrup, dextrin* constitutes by far the largest part. The sugars are divided into two classes; cane sugar and the reducing sugars. The latter are so called because of their action when properly treated with a solution of certain chemicals. As to the relative value of the two classes of sugars little can be said. Good authorities state that 1 pound of cane sugar has as much sweetening power as 1½ pounds of grape sugar. Grape sugar is one of the more important reducing sugars. It is generally conceded, however, that for the purpose of nourishing the body these two classes of sugars are quite equal.

---

*Dextrin is always formed during the digestion of starch in the human body and possibly has a food value equal to that of sugar.

In the appended table the number of pounds per gallon of the different ingredients named are shown, the average total weight of a gallon of syrup being 11½ pounds. An examination of the table will show that in total sugars per gallon, sorghum syrup stands high and in the amount of cane sugar it contains it is surpassed only in some of the better qualities of New Orleans molasses and in pure maple syrups. The pure maple syrups contain the highest proportion of cane sugar of any of the syrups examined. They are of course especially valued for their peculiar flavor and sell at a high price.

A further examination of the table will show that few syrups contain 8 pounds of sugar per gallon. When such syrups are bought at 40 cents per gallon, 20 pounds of sugar will be obtained for $1; when bought at 50 cents per gallon, 16 pounds of sugar will be obtained for $1; and when bought at 60 cents per gallon only 13⅓ pounds of sugar will be obtained for $1. In each instance a portion of the sugar thus obtained will be the inferior reducing sugars.

A good article of table syrup may be made by melting about two pounds of sugar with a pint of water. To those who object to the flavor of this syrup, it may be said that the most delicate flavors may be produced by substituting for the water a less quantity of the juice of almost any of the numerous domestic fruits which are so readily grown in the State, and the converting of the whole into jellies. Recipes for these various jellies may be found in almost any cook book and need not be given here. Suffice it to say that the making of such articles for home use will be profitable employment of much time which would probably otherwise be wasted, and that the careful beginning of such work on a small scale might lead to the profitable manufacturing of such articles for market.

In conclusion it may be said that the relative value of different syrups is largely dependent upon the individual taste of the consumer, and that the selling price has no relation to the actual food value of this article.

Table Showing Contents of Syrups Examined.

No.	TRADE NAME.	Price per Gal.		Contents in Pounds per Gallon.				
		Wholesale	Retail.	Ash.	Water.	Cane Sugar.	Reducing Sugar.	Total Sugar.
		$	$					
1	New Orleans Molasses, Crop of 1894....	.44	....	.16	2.7	2.0	3.6	5.6
2	St. Clair O. K. Sugarhouse Molasses....	.35	.. ....	.24	2.9	5.5	1.7	7.2
3	Upper Ten Syrup..............................	.27	....	.07	2.1	0.5	4.7	5.2
4	Syrup De Bateil, (Sold as Sugarhouse)	.21	....	.17	3.7	6.2	1.2	7.4
5	China Grove....................................	.41	....	.34	3.2	5.3	2.0	7.3
6	Economy Syrup..................................	.18½	....	.07	3.0	0.7	3.7	4.4
7	Log Cabin Maple Syrup, per quart	.35	....	.03	3.5	7.0	0.5	7.5
8	Lauderdale Sugarhouse Molasses.	.28	......	.36	2.8	4.3	3.5	7.8
9	Rebailed Sugarhouse—Golden................	.25	....	.26	2.3	2.1	3.6	5.7
10	Pure Sugarhouse—Bertha.......................	.29	....	.37	3.2	5.2	2.2	7.4
11	Jackson County Sorghum.......	.25	....	.22	2.8	4.9	3.2	8.1
12	Sugarhouse Molasses —Woodlawn........	.32	....	.20	3.2	1.0	3.1	4.1
13	New Orleans Molasses	....	.65	.37	3.4	5.0	2.4	7.4
14	New Orleans Molasses	....	.40	.33	3.2	5.1	2.4	7.5
15	Sorghum Molasses..................................	....	.45	.37	3.5	4.8	2.6	7.4
16	Loaf Sugar Syrup....................................	....	.65	.06	2.9	4.2	2.0	6.4
17	Golden Drips..	....	.45	.07	2.8	1.0	3.9	4.9
18	Sugar Loaf Syrup....................................	....	.50	.20	2.8	1.7	4.3	6.0
19	Chase's Royal Drops Syrup......................	....	.65	.06	2.8	3.2	2.5	5.7
20	Maple Syrup..	....	1.50	.02	2.9	7.2	0.2	7.4
21	Corn Syrup..	....	.40	.09	2.1	0.5	4.4	4.9
22	New Orleans Molasses	....	.40	.29	3.0	5.5	2.4	7.9
23	Old Plantation Molasses.........................	....	.65	.21	3.0	6.1	1.8	7.9
24	Heavy Sugar Syrup.................................	....	.50	.31	2.1	4.8	3.2	8.0
25	Sorghum Molasses..................................	....	.40	.42	2.5	5.0	3.1	8.1

Bulletin 22—Sorghum and Sugar Cane Culture and Syrup Making—a few copies of this Bulletin are still on hand and can be had upon application.

G. L. Teller, Chemist.
J. F. Moore, Assistant.

GENERAL INDEX.

Letter of Transmittal 2
Contents 3
Board of Trustees 4
Station Staff 4
Financial Report 5
Report of Director 6

AGRICULTURE—

Fattening Mature Steers on Cotton Seed and Cowpea Hay 3
Cowpeas 11
Sweet Potatoes 16
Peanuts 19
Cotton Varieties, Egyptian and American 23
Artichokes 24
Turnips and Mangel-Wurzels 26
Food for Hogs 27
Heel Scrape and Scooter 28

FARM DRAINAGE—

Drainage 33
Protection of Soil from Surface Washing 34
Hillside Ditches 36
Terraces 41
Drainage of Wet Lands 44
Indications of the Need of Drainage 45
Open Ditches 49
Underdrains 50

INSECTS—

The Insects Injurious to Fruits and Vegetables and Remedies for Destroying Them 55

VEGETABLE GARDENING—

Vegetables—Varieties, Culture and Fertilization 99
Sundry Experiments with Field Crops 124

ANIMAL PATHOLOGY—

Diseases of Farm Animals 129
Verminous Bronchitis 130
Parturient Apoplexy of Cows 138
Hog Cholera and Other Swine Diseases 144
Tuberculosis of Cattle 147
Glanders in Horses and Mules 155

GRASSES AND CLOVERS—

Suited to Different Soils for Pasture and Meadow 159

SYRUP AND MOLASSES—

Do 181

AGRICULTURAL
LIBRARY,
UNIVERSITY
OF
CALIFORNIA

Agricultural Experiment Station

FAYETTEVILLE ARKANSAS.

NINTH ANNUAL REPORT

1896.

NOVEMBER, 1896.

Agricultural Experiment Station

FAYETTEVILLE ARKANSAS.

NINTH ANNUAL REPORT

1896.

NOVEMBER, 1896.

ARKANSAS EXPERIMENT STATION,
FAYETTEVILLE, ARK., November 10, 1896.

To His Excellency, JAMES P. CLARKE,
Governor of Arkansas:

SIR—

I have the honor to transmit to you herewith the Ninth Annual Report of the Arkansas Agricultural Experiment Station.

Most respectfully, your obedient servant,

R. L. BENNETT,
Director.

CONTENTS.

Page.

LETTER OF TRANSMITTAL 2

BOARD OF TRUSTEES 4

STATION STAFF 4

FINANCIAL REPORT 5

REPORT OF DIRECTOR 6

REPORT OF ASSISTANT AGRICULTURIST 3

REPORT OF HORTICULTURIST 17, 107

REPORT OF VETERINARIAN 35

REPORT OF AGRICULTURIST 45

REPORT OF CHEMIST 61

Agricultural Experiment Station.

BOARD OF TRUSTEES.

His Excellency, J. P. CLARKE, *President.*

HON. W. H. LANGFORD.
HON. C. C. HAMBY.
HON. B. C. BLACK.
HON. W. N. YATES.
HON. J. B. McDONOUGH.
HON. JAS. T. HENDERSON.

BOARD OF CONTROL.

HON. J. T. HENDERSON. HON. W. H. LANGFORD. HON. C. C. HAMBY.
THE PRESIDENT OF THE UNIVERSITY. THE DIRECTOR OF THE STATION.

STATION STAFF.

R. L. BENNETT	DIRECTOR and Agriculturist.
GEO. L. TELLER	Chemist.
R. R. DINWIDDIE	Animal Pathologist and Bacteriologist.
J. T. STINSON	Horticulturist.
C. L. NEWMAN	Assistant Agriculturist at Camden.
GEO. B. IRBY	Assistant Agriculturist at Newport.
J. F. MOORE	Assistant Chemist and Librarian.

Correspondents will please notify the Director of any change of Post Office Address, error in Address, or failure or delay in receiving Bulletins.

R. L. BENNETT, Director,
Fayetteville, Ark.

FINANCIAL REPORT

AGRICULTURAL EXPERIMENT STATION.

In Account with the United States Appropriation.

1896 DEBTOR.

To Receipts from the Treasurer of the United States as per Appropriation for the year ending June 30, 1896	$15,000 00
	$15,000 00

CREDIT.

By Salaries	$ 8,582 35
Labor	1,364 31
Publications	1,093 10
Postage and Stationery	146 55
Freight and Express	247 71
Heat, Light and Water	64 70
Chemical Supplies	270 95
Seeds, Plants and Sundry Supplies	529 00
Fertilizers	65 55
Feeding Stuffs	78 15
Library	360 95
Tools, Implements and Machinery	324 05
Furniture and Fixtures	303 25
Scientific Apparatus	138 30
Live Stock	43 50
Traveling Expenses	594 40
Contingent Expenses	81 50
Building and Repairs	711 68
	$15,000 00

The foregoing Statement is copied from the Experiment Station books, which have been duly examined and found correct by the Auditing Committee of the Board of Trustees.

R. L. BENNETT,
Director.

REPORT OF DIRECTOR

This report contains the completed work and financial statement of the fiscal year ending June 30, 1896.

The completed work of the year is contained in six Bulletins, and a full text of each appears in the succeeding pages.

The Bulletins and their subject matter are as follows:

Bulletin 38—Irish Potatoes.
Bulletin 39—Spraying Fruits, Strawberries, Grapes.
Bulletin 40—On the Toxic Properties of Molds—Field Investigations of Various Stock Diseases.
Bulletin 41—Pork Production on Crops Gathered by Hogs—A Succession of Crops for Hogs.
Bulletin 42—Part 1—Concerning Wheat and its Mill Products.
Part 2—Chemical Study of Wheat.
Bulletin 43—Annual Report on Apples, Grapes, Strawberries, etc.

Interest in the Station work has continued to increase and the general inquiry by cotton farmers for information on all kinds of agricultural subjects, caused largely by the low price of cotton, has continued. The work of the Station is being more generally read and utilized every year by this large class of farmers. Almost every farmer in the State, especially in the cotton sections, is a cotton farmer, and the kind of experiments that they are most interested in are new methods and new crops; and for that reason the experiments of the Agricultural Division of the Station have been directed almost entirely to those lines of work. The economic production of beef and pork, and soil improvement have been given considerable attention. The kitchen, garden and truck growing have also been a subject of considerable work. The Horticultural Division experiments have been along the lines of protecting fruits, and improved methods of culture, and is meeting the increasing demand for this kind of information. The Chemical and Bacteriological Divisions have been doing more largely original scientific investigations. The chemical work has been more particularly on the proteids of wheat and methods for their separation, while bacteriological work is chiefly with the destructive diseases among hogs in this State.

R. L. BENNETT,
Director.

IRISH POTATOES.

It is very probable that within the State of Arkansas no product is attracting more attention than the Irish potato, and the coming season will witness a considerably increased acreage devoted to this crop. The large yields, the excellent quality of the potatoes harvested during the past few years, and the high prices they have brought on the market, will induce many to undertake the cultivation of this crop on a commercial scale who may stand in need of information on the subject. It is in anticipation of this demand for information that these pages are written, and with the hope that the recital of principles and practices that have proven successful in the past will not be less so in the future. This paper is not, however, intended as an exhaustive treatise on the subject of potato raising, but is merely a collection of information drawn largely from the experience of others and partly from the experience of the writer, more with the hope of giving instruction to the beginner than with the expectation of guiding the expert. The beginner in any industry or undertaking is necessarily ignorant of the many details the proper observance and execution of which constitute the difference between success and failure or profit and loss.

The Station is now and for two years has been conducting special potato experiments, but they are not ready for publication. It is intended that this paper shall give the most important facts relative to potato growing in this State and in a practical manner, thus enabling the beginner to construct for himself a foundation, upon which, with personal experience and observation, he is to erect the edifice of success. But it must not be expected that all who undertake potato growing will meet with profit or success. The conditions that produce failures are more numerous than those from which success results. It is very necessary that he, who for the first time undertakes a market crop, thoroughly fortify himself with information before making the attempt. The best information he can obtain is from the experience of those who have been successful—not, however, one man's success in one season and on one class of soil, but the successes *and failures* of a number of men under different circumstances and conditions so assorted as to suit the surroundings of the individual.

The most profitable potatoes grown in the South are the *extra early* spring crop and the fall crop. The early spring potatoes are shipped North as soon as harvested, reaching the market four or eight weeks ahead of the Northern grown spring potatoes and sell at a premium. The fall grown potatoes possess remarkable keeping qualities and sell everywhere at a premium, and are highly prized for seed.

SPRING CROP—SELECTION OF SOIL AND ITS PREPARATION.

The best soils for potatoes are neither too light nor too heavy, but varying between sandy loam and clay loam, and deep. It is of the greatest importance that the soil be thoroughly drained either naturally or artificially. This is particularly true of the extra early spring crop. Excess of water the soil not only delays the maturity of the crop, but decreases the yield, impairs the quality of the product and makes it more liable to rot. The aim of the commercial potato grower should be to produce on the smallest area the largest quantity of earliest potatoes of the best quality with the least expenditure of time and labor. He must have good seed, good soil well manured, and cheap transportation facilities.

The preparation of the soil should not be delayed until the seed are ready to go in the ground, but for the spring crop should begin the year previous. In the early fall it should be thoroughly plowed (and subsoiled very probably) and seeded to rye, crimson clover or something similar for winter protection. If a heavy crop of cowpeas occupy the land they may be left undisturbed until February, or they may either be cut or turned under and the land prepared and seeded to rye or crimson clover. This winter growth of vegetation not only has a tendency to prevent washing and leaching, but turned under in February affords excellent food for the potato crop. Thus all the benefits of fall plowing are secured without the injuries that would result from leaving the ground bare during winter. It is true that heavy and harsh soils are benefited by fall plowing even if left bare through the winter, but such soils are not good for potatoes and would be all the more benefited by a covering of vegetation. Further north where the soil remains frozen the greater part of the winter fall plowing is beneficial, but where the winters are open as in Arkansas the heavy rains of winter and early spring will dissolve and leach a large portion of the soil's fertility, hence the importance of *early* fall plowing followed immediately by the sowing of the crop for winter protection, that it may hold this soluble plant food until it is needed the following spring.

The spring preparation should begin as early in February as the condition of the soil will admit of, by turning over as deep as it has been previously plowed. Then run the harrow until the soil is thoroughly pulverized and regular, but do not use the roller unless clods remain unbroken after repeated harrowing. If it is necessary to use the roller, harrow again after rolling, for potatoes delight in a loose and not a compact soil. In all cases the preparation should be deep, and subsoiling would pay on many soils, but as to whether subsoiling should or should not be practiced is a matter to be determined by the individual. The State contains such a variety of soils that while some would be greatly improved others might be materially injured by subsoiling. Should a heavy rain occur after the early spring plowing and before the potatoes are planted, the harrow should be run as soon after the rain as the soil is sufficiently dry, to loosen the surface and maintain its porosity.

MANURES AND FERTILIZERS.

A judicious application of plant food, whether in the form of home-made manures or commercial fertilizers will often double the yield, not only of Irish potatoes, but of the majority of other crops. This is particularly the case when the application is made in conjunction with some renovating crop such as cowpeas. While stable or barnyard manures have no equals for crops in general, they must be applied to potatoes with some caution as they often cause or increase the diseases known as "scab" and "rot." They should never be applied to the soil fresh, but piled and forked over and mixed thoroughly that the process of fermentation may reduce them to a fine condition. This not only decreases the liability of injury resulting from the above diseases, but leaves the manure in a condition to be better utilized by the crop. Commercial fertilizers, it is believed, have a tendency to decrease the effects of both "scab" and "rot." A good plan is to apply at least a portion of the manures to a crop of peas the season before, or to a fall crop of grain or crimson clover to be plowed under in February, at which time the balance of the manures may be distributed. Fresh animal manures, or those which have not passed through the fermenting or heating process, should never be applied in the drill, but broadcast and thoroughly incorporated with the soil. To this end they must first be equally and evenly spread when hauled to the field, that the plowing and harrowing that is to follow may more thoroughly mix them with the soil. When commercial fertilizers are to be used it is best and cheapest to purchase the separate ingredients, mix at home and apply in the drill, running a broad scooter in the drill after they are put down to thoroughly mix with the soil. This thorough incorporation in the drill must be insisted upon to secure the best results. It is not advisable to purchase so-called complete fertilizers. The ingredients can be bought separately and mixed in proportions to suit the soil and the crop at a much reduced cost (see appendix). The most expensive element of fertility that the potato grower must use, if he has it to buy, is nitrogen, but a good crop of pea vines grown on the soil and returned to it will furnish all the nitrogen needed for one crop. The value of the peas grown will more than pay the cost of planting and plowing in the vines. Clover, where it can easily be grown will answer. Having thus grown the nitrogen at home the potash and acid phosphate may be purchased and applied, well mixed and thoroughly incorporated with the soil in the drill, having also manured the nitrogen-supplying crop with potash and acid phosphate. If the soil intended for potatoes is not rich it should be made so before planting time. It will not pay to attempt commercial potato growing on poor land, nor is it wise for the beginner to attempt a large area. He will find that a small area well manured and well cultivated will give a greater profit with less risk than a large area poorly cared for. Two plots of potatoes grown on the station grounds in '95 illustrate this point. The soil of both plots was originally of equal fertility. Plot A was well manured while plot B was given only 200 pounds of cotton seed meal. Plot A had also been well manured the year previous for vegetables. The following is the account of each plot:

PLOT A.—EXPENSES PER ACRE.

Preparation of soil	$ 3.00
Seed	10.00
Cutting and Planting	4.50
Cultivating four times with harrow and plow	2.00
Hoeing twice	1.50
Gathering	4.32
10 loads stable manure and distributing	7.50
300 pounds cotton seed meal	2.40
500 pounds kainite	4.00
250 pounds acid phosphate	2.25
Distributing C. S. M.	20
Distributing kainite and phosphate	25
Total cost	$ 41.92

RECEIPTS PER ACRE.

30 bushels culls, at 30 cents	$ 9.00
186 bushels merchantable, at 50 cents	93.00
Total receipts	$102.00
Total cost	41.92
Profit	$ 60.08

PLOT B.—EXPENSES PER ACRE.

Preparation of soil	$ 3.00
Seed	10.00
Cutting and planting	4.50
Cultivating four times with harrow and plow	2.00
Hoeing twice	1.50
Gathering	94
200 pounds cotton seed meal	1.60
Distributing C. S. M.	20
Total cost	$ 23.74

RECEIPTS PER ACRE.

21½ bushels culls, at 30 cents	$ 6.45
26 bushels merchantable, at 50 cents	13.00
Total receipts	$ 19.45
Loss	4.29

Adding the loss of plot B to the profit of plot A gives a difference o $64.37 resulting from the additional expenditure of $16.15 for fertilizers and manures. It must be remembered, however, that plot A was also well manured with cotton seed meal and stable manure for the vegetables grown on the plot the year previous, while plot B had been given but a meagre ration for cotton. The vegetables grown on plot A the previous year were lettuce and beans followed by sweet corn and the corn followed by cabbage in the fall. Plot B had never been plowed deeper than 4 inches, while plot A was thoroughly broken to twice that depth in January when the stable manure was plowed in. The cotton seed meal, kainite and acid phosphate were applied in the following manner: The rows were opened

8 or 9 inches deep with two or more furrows of turning plow and the mixed materials put down by hand. A 4 inch scooter was run twice in each row to thoroughly mix the fertilizers and prevent their coming too much in contact with the seed. The seed, cut to two, three and four eyes, were dropped 15 inches apart in rows 30 inches wide and covered about 4 inches. Plots A and B were both harrowed level before the potatoes came up and again when about half of them were up. The harrow was run across the rows in each case.

WHEN TO PLANT.

The time of planting will necessarily to a great extent be controlled by the weather, but it is advised that planting begin in south Arkansas as soon after February 10 as possible; in middle Arkansas ten or fifteen days later, and still later in the northern part of the State. Of course there is some risk of having the young plants cut back by a freeze or blackened by frost, but it is the extra early potatoes that pay best, and the earlier they can reach the market the better the prices will be. Potatoes may be cut back into the ground by freezes and recover and make a heavy yield, though they will be some later in maturing. It would, however, be safer to plant at intervals—some at the earliest possible date and some later. The early planted potatoes have the advantage of being less liable to injury from drouth, insects, blight, rot, scab, etc., as these rarely appear before June 1, by which time if the potatoes are not ready for the market they are sufficiently advanced towards maturity to escape with but slight injury. Early potatoes can be protected from a late killing frost by covering the tops with two furrows and afterwards removing the earth with harrow.

PLANTING.

When the time for planting arrives all preparations should be complete that there be no delay. A postponement of a few days followed by unsuitable weather may force a delay of a week or more if a planter is not used. Lay off the rows 30 or 36 inches apart and deep enough to leave the seed 3 or 4 inches below the level surface of the ground. The rows are best opened with a large double shovel or with a light turning plow and it is often advisable to run twice in each row throwing the soil both ways. The seed cut to not less than two eyes are dropped 12 or 15 inches apart and covered as soon as possible, leaving a slight ridge directly over the row. This ridge will be leveled before the potatoes come up by harrowing across the rows. The harrow destroys the first crop of weeds, breaks the crust that may have formed and leaves the soil surface well pulverized that the young plants may have no difficulty in coming through. On well drained soil there is but slight advantage in hilling the rows—the potatoes probably would be a few days earlier but the yield would be less. The rows will unavoidably become slightly elevated above the middles as cultivation progresses, but even this should be avoided as far as possible consistent with frequent and thorough shallow cultivation. If the soil remains too wet after rains slight ridging would be advantageous.

CULTIVATION.

The Irish potato is a quick maturing crop and should be given frequent shallow cultivation, beginning with the harrow before they have come up, as mentioned above, and harrowing again, if everything is favorable, when about half a stand is secured. This second harrowing may also be across the rows without material injury to the young plants. If a rain should occur after the first harrowing and before the plants appear it is very necessary that the harrow be again run over the field as soon as the soil is sufficiently dry. It might be remarked here that care should always be exercised that no cultivation be done while the soil is the least too wet. On the other hand all growing crops subject to cultivation should be gone over as soon after each rain as the soil will admit. The work is then more easily and more cheaply done, the fresh crops of grass and weeds are killed without trouble, crust does not form and air is admitted into the soil and moisture retained. At no time is it advisable to cultivate deep when the soil was properly prepared, with the possible exception of the first plowing after the plants are up when a heavy or continuous rain has fallen. It may then, in some soils, be better to plow deep if the crop is yet quite young. When the young plants show well along the rows and are too large to be harrowed without damage, no implement will do better work than a properly adjusted heel-sweep, either for killing foreign growth or stirring the soil's surface. The use of this implement can be continued until the vines begin to meet across the rows. Several cultivators are now on the market that do good work in the potato field.

Properly cultivated potatoes will at all times be free of weeds and grass unless continuous wet weather prevents cultivation. Two or three hoeings may be necessary to keep the rows clean. If all weed growth is suppressed until the vines fill the rows their shade will largely prevent further foreign growth.

If the potatoes grow through and appear upon the surface of the soil as is sometimes the case where the yield is very heavy, enough earth may be thrown to the vines to cover them or they will become green and unsalable.

VARIETIES.

The varieties of the Irish potato have multiplied of late years to so great an extent that it is difficult to keep up with them. The best potato for the early market crop is that variety which best combines earliness, table and and shipping qualities, size, shape and productiveness. These qualities are more than apt to vary in the same variety planted in different localities. The variety succeeding best in one locality is often inferior to other varieties elsewhere. In this State the Bliss Triumph and Early Ohio seem to be the most popular for the extra early crop, while the Beauty of Hebron and Rural New Yorker No. 2 succeed well and produce more, but are later. Many believe the Early Rose the earliest and best of potatoes, while in fact it is only medium in earliness, quality and yield, and a number of varieties are better. Bliss Triumph is more extensively grown than any other variety in this State, but its color is objectionable in some markets and causes it to sell at a lower price. A person growing potatoes for market can best judge for himself the varieties best suited to his soil, climate and market and should plant a few rows of those varieties recommended elsewhere that he may draw his conclusions from the results obtained on his own soil.

In 1895 nine varieties of general popularity were planted February 23, on *heavily manured* sandy soil for the purpose of making a comparison of their yield, earliness and other qualities. The following table gives the results in a condensed form:

NAME OF VARIETY.	Yield per Acre in Bushels.	Order of Size.	Order of Shape.	Order of Whiteness.	Order of Mealiness or Cooking Quality.	Order of Earliness.
Beauty of Hebron	405	6	5	5	7	4
Boston Peerless	217½	8	9	7	9	6
Extra Early Vermont	246¼	4	6	1	6	2
Early Triumph	165½	7	2	2	5	1
Northern Peerless	287½	1	1	3	3	7
Rural New Yorker No. 2	156¼	2	3	6	4	3
Snowflake	337½	3	4	8	1	8
Vermont Early Rose	232½	5	8	4	8	5
White Elephant	342½	9	7	9	2	9

The above yield is in *merchantable* potatoes and does not include culls, which however, in no case amounted to over 33 bushels per acre.

While the Triumph matured fully ten days before any other variety several others *at that time* had more and larger potatoes, notably the Extra Early Vermont and Beauty of Hebron.

SAVING SEED.

The saving of seed potatoes can easily be improved upon. It is too often the case that the better potatoes are marketed and only the culls retained for the next planting. The seed should be sorted from the other potatoes as dug, and it would be better to select as the digging progressed from only the best yielding plants, the matured, smooth and perfect shaped potatoes, not below medium in size. If you expect to continue saving your own seed select only such specimens as you would like for your next crop. For potato growing on a large scale it will pay to plant a part of the crop for the especial purpose of growing seed by using the best seed on the best soil; give the best preparation, manuring and cultivation and save for seed only the best specimens. This practice continued through several generations of potatoes will show a marked improvement not only in the yield, but in shape, size and quality, and more than pay the cost.

DIGGING.

Unless intended for immediate use the early crop should not be dug until mature or nearly so. If dug while in a growing condition the skin will slip and the tubers turn black, making them unfit for market. The exact time to dig will be indicated by the vines ceasing to grow and the leaves turning yellow. It is not safe to dig some varieties for shipment before at least half the vines are well yellowed. When dug, however, the soil should be sufficiently dry to prevent its adhering to the potatoes. Digging is generally done either with a four tined fork or with potato plows made for the purpose. Of the latter there are several makes on the market made for the purpose and costing from $6 to $30. Barring off with light turning plow facilitates this work. A good hand with experience can with spading fork dig from 8 to 16 bushels per hour, or faster than an ordinary hand can pick up and sort, and if careful will leave but few potatoes in the field. If the vines give much trouble they may be cut and raked to one side. The potatoes should not be allowed to remain in the sun or wind, but picked up as soon as dry. If not to be packed at once they should be piled and covered with vines, or if packed in the field the packages should be shielded from the sun. The sorting is better and quicker done while picking up. All that are cut, small or badly shaped should be sorted or they will injure the sale of the others. It is too often the custom to save the small potatoes for seed for the second crop. If this is persisted in it will sooner or later impair the good qualities of the variety. Both digging and after handling should be done with the greatest care to avoid bruising.

Sacks are mainly used in this State for shipping to market, but ventilated barrels or crates are preferable, and potatoes thus put up sell better than those in sacks. If sacks are to be used those with a capacity for 1½ bushels (or 90 pounds) are preferable. They carry longer and better, however, in barrels or crates, if well ventilated. In whatever packages they are shipped the packages must be neat and clean in appearance, well and symmetrically made and so well filled that they will be full when they reach their destination. If filled carelessly the jarring received in transit will leave an empty space at the top and the loose potatoes will become bruised. To avoid this the barrel or crate should be so filled that the contents will bulge, requiring shaking and considerable force to press down the head or slats. If barrels are not convenient *barrel crates* may be made of three boards 11x20 inches, one in the middle and one at each end, and slats ½x2½x39 inches at the sides, bottom and top. This gives a crate 39 inches long, 20 inches deep and 11 inches wide, holding the same as a barrel. For such a crate bright sap pine will answer better than other materials, cost considered.

MARKETING.

When a number of farmers ship from the same point it is, no doubt, best for them to associate themselves together and appoint some one to attend to shipping for all. Market prices and condition by wire can thus be secured cheaper for each shipper. If good prices are offered on board cars at shipping point and the cash paid down before shipping, it would no doubt be better for small farmers than to ship on consignment. Drummers for consignment are to be avoided. When shipping on consignment do so only to commission merchants known to yourself or to your banks to be reliable. Cattle cars are superior to ordinary box cars on account of superior ventilation. Ship only good size, well shaped and uniform potatoes and handle at all times with the uttermost care.

Fall Grown Potatoes.

Fall grown potatoes, and more particularly the "second crop," have attracted considerable attention within the past few years and are rapidly becoming an important product for the Southern farmer. They are sometimes grown from seed kept over from the previous year and called the "fall crop," but most generally from spring grown seed of the same year and called "second crop." It is difficult in the South to keep seed potatoes over from the previous year's spring crop and a large majority of the fall planted potatoes are grown from the spring seed and are in reality a second crop. The conditions favorable to the sprouting of potatoes are often wanting at the time of planting, and the failure of this crop is frequently due to the rotting of the potatoes before and after planting, or their failure to sprout. This rotting and failure to sprout is due to excess of heat and insufficient moisture, and to successfully grow fall potatoes these adverse conditions must be obviated as far as possible. This can be done partly by the selection of a deep and fertile soil well capable of retaining moisture. The potato succeeds best in a cool temperature.

PREPARATION OF THE SOIL.

That the soil may be in the best tilth to insure success, preparation for fall potatoes should begin in the early spring, by planting some heavily manured crop, other than potatoes, that may be harvested or plowed under three or four weeks before the potatoes are planted. For this purpose the cowpea has no superior, and if sown thick about April 15 or May 1 on well manured soil, may either be cut for hay or plowed into the soil the 1st of July. Aside from the manural value of the pea vines the dense shade and deep penetrating tap roots will increase the soil moisture. A clover or grass sod makes an excellent crop to precede potatoes also. To the crop occupying the soil the spring before the potatoes are planted should be applied a goodly proportion of the manures or fertilizers intended for the potatoes.

The soil should be broken eight, ten or more inches deep when preparing for this crop and rebroken before planting. This second plowing should be done about July 1 or 10 and afterwards the surface must be stirred every few days and by all means after each rain for the double purpose of retaining moisture and keeping down weeds and grasses. If the soil is kept harrowed level less surface will be exposed to the drying effect of the sun and wind. If additional manures are to be used on the potatoes it is better to put it down broadcast before the second plowing than to use it in the drill when the potatoes are planted. If it can be avoided the fall planted potatoes should not be on the soil that grew the spring crop, but should follow some well manured crop requiring plant food in different proportions from the requirements of the potato and not subject to the attacks of the same fungi and insects.

MANURES AND FERTILIZERS.

Fall grown potatoes are generally planted on soil from which one (sometimes two) crop has already been gathered. If this spring crop was heavily manured it is not always necessary to make an additional application for the fall crop. In fact it is better to apply the manure intended for the fall potato either in the spring or some weeks at least before the potatoes are planted. No fertilizing materials, with the possible exception of potash salts, should be applied in the drill for fall potatoes. Horse and cow manures and composts are particularly objectionable, and are liable to do more harm than good, if applied fresh at the time of planting or a short while before. As suggested before, no better preparation can be made than by sowing cowpeas thick early in the spring on deeply broken soil well fertilized with potash and phosphoric acid.

VARIETIES AND CARE OF SEED.

The best varieties for the extra early spring planting are also the best for the fall crop. The extra early varieties may be planted later and escape more of the hot summer weather than the late varieties and still have ample time to mature before frost. Another advantage of the early varieties is that they make better seed for the second crop, as they have ample time to become thoroughly mature.

Bulletin No. 112 (pp. 74–75) of the North Carolina Experiment Station recommends that "the potatoes from which it is desired to grow the second crop should be allowed to remain where they grew until perfectly ripe and the tops dead. If they are selected from the culls in digging the partly matured crop for shipping, there will be much uncertainty as to their sprouting. When the tops are dead take them up and allow them to remain a day or so exposed to the light until they turn greenish. Then spread them in any convenient place on the ground and cover them with pine or other straw. Sprinkle the straw and thereafter never let it get dry all through. Prepare the land as for the early crop, except that the fertilization need not be so heavy, and run out the rows by going twice in a furrow with a turning plow and clean out the furrow fully six inches deep. As the under the straw begin to start the eyes, which will be from the first to the middle of August, plant them in the deep furrows and cover them not more than an inch over the top of the tubers, until the green leaves begin to grow. Then gradually fill in the soil to them as they grow, until it is level. The after cultivation must be as level as possible and no hilling should be done, the object at this season of the year being to prevent the drying out of the soil. The potatoes will sprout earlier, if, before bedding them under the straw, a small piece is clipped off one end and rejected. No further cutting should be done when planting."

PLANTING.

In the northern half of the State planting should be done between July 15 and August 1—in the southern half, between August 1 and 15. Everything should be ready that the planting may be done with dispatch when the conditions are favorable after a rain. Open out the furrows 6 inches deep by running twice with a turning plow. The plow should be run 8 inches deep, leaving about 2 inches of moist, loose soil in the bottom of the furrow. Drop the seed and *cover immediately* with furrows of turning plow. Neither the seed nor the soil in the furrow must become the least dry. They should be dropped as soon as the furrow is opened and covered as soon as dropped. A ridge 2 or 4 inches high will be left over the potatoes and a roller should be run over each row that the soil may be firmer around the potatoes, and a harrow should follow the roller, thoroughly loosening the *surface* of the soil, thus forming an inexpensive mulch that both retains moisture and prevents the soil's baking, and at the same time leaves the field level. It would be well to run the harrow twice over the field—the first time behind the roller and with the rows, and across them the second time. If no roller is at hand it is all the more necessary that the harrowing be done.

All seed should be cut before planting, no matter how small. If very small cut a small piece from the stem end, but discard this piece. Medium size seed should be halved from bud to stem end, while the larger may be quartered in the same manner. Drop from 12 to 15 inches apart in 30 or 36 inch rows. At this season of the year it is of very great consequence that the soil be pressed about the seed. If a roller is not convenient this may be done by stepping on each piece as it is dropped and pressing it into the loose soil in the bottom of the furrow. This is practiced by some successful growers and seems to answer the purpose of rolling. When rolled it is always advisable to harrow immediately afterwards.

For planting on a small scale, the seed may be spread thinly on the ground in a cool, shady place, covered with straw or loose earth and kept moist by frequent watering until sprouting begins. As they sprout they are taken up and planted in freshly opened furrows and covered at once. If in sprouting the seed they are covered with loose earth, it should not be more than 1 inch above the potatoes. As the young sprouts come through, they are taken up with the potato and planted. If the covering is straw it should be 4 or 6 inches deep. After sprouting begins it may be temporarily removed every day or two and the sprouted potatoes selected and planted. If the young plants are tender and liable to rub off in handling, they should he exposed for a day or two to the light, when they will become green in color and may be handled with but little danger of rubbing off.

CULTIVATION.

Cultivation of fall potatoes should begin as soon as planted and before they show above ground. If in planting a ridge is left over the row, harrow level before the potatoes come up, and continue the use of the harrow until the young plants show well along the row. After this, plowing must be frequent, and always after a rain, as soon as the ground is in condition to be stirred. For this work no implement is better than the heel-sweep, but there are several side-harrows and cultivators, such as the Planet, Jr., that do good work. Never cultivate the fall crop deep, but give such cultivation as will not only keep down grass and weeds but will also leave the surface between the rows level and always loose and fine, and without breaking any roots. Two or three hoeings may be necessary to keep down weeds. But foreign growth will not injure the crop so much as will a crust on the surface of the soil, and the act of preventing this crust will destroy the majority of the weeds. Cultivation of the fall crop may continue until the potatoes approach maturity.

ROTATION AND RENOVATION.

It is a well known fact that a very large majority of plants, if grown year after year on the same soil, will not give the best results, even when supplied with the necessary plant food and in the proper proportion, and not taking into account the injurious effects of insects, fungi and weeds. With the Irish potato rotation is very necessary, and at least one year should intervene between crops, during which time no plant of the same family, such as tomatoes, egg plants and pepper, should occupy the soil. On sandy soils particularly is rotation important, for they more readily part with their plant food, and are specially suited to early and quick maturing vegetables. On deep alluvial and strong clay soils rotation is not so necessary, but on such soils the practice is "the best method of keeping the soil clean, mellow and in the best attainable condition for the production of remunerative crops, with the least cost of manure" and labor. It is often the practice to plant the second crop on the same soil from which the spring crop was taken, but this plan cannot be recommended, and the soil will soon rebel if the abuse is persisted in. At least two crops should be grown before potatoes are planted again on the same ground, and one of them, preferably the second, should be a renovating crop. The most costly fertilizing element that is necessary to be applied for potatoes is ni-
n, and this renovating crop can be made to supply a part, if not all,

that the potato needs. For renovation the cowpea has no equal at the South, and takes the same place at the South that clover does at the North, with the advantage of producing a heavy growth in four months, while the majority of Arkansas soils will grow but inferior clover, and requires a year or two for its production. On suitable soil, and in a favorable season, August sown crimson clover may be employed to advantage for supplying nitrogen to the spring crop, and in addition it does valuable service by its winter protection. It will furnish a good growth by February 15 or March 1. As the potato requires only three or four months from planting to maturity, a large portion of the truck crops have ample time for marketable maturity before the fall crop is planted and after the spring crop is harvested. Thus the onion, cabbage, cauliflower, beet, bean, radish, turnip, pea, corn, etc., may be grown the same year and on the same soil, either before the fall or after the spring crop of potatoes. But whatever order of rotation is decided upon, each crop should be fertilized, and a renovating crop grown after every second market crop, or, at least, before the same market crop is planted the second time on the same soil.

Potato Scab.

This disease should be guarded against by using only healthy seed and planting in soil known not to be infected. Should the use of infected seed be unavoidable they should be treated in the following manner: In 2 gallons of hot water dissolve 2 ounces of corrosive sublimate and allow to stand until the following day. Use only wooden or earthen vessels. Add this solution to 13 gallons of water in a barrel or tub. Stir well and immerse the thoroughly washed seed for one and a half hours. Empty the solution from the seed into another barrel or tub to be used again. Both the corrosive sublimate and the solution must be handled with care, as either is a deadly poison to man or beast, if taken internally. If any treated potatoes are not planted they must be destroyed at once, preferably by burning. The solution may be used a number of times.

Blight and Rot.

These fungous diseases attack both the vines and the tubers. The Bordeaux mixture applied when the vines are 8 or 12 inches high and the application repeated every ten or fifteen days is an effective remedy. The mixture is made as follows: Dissolve 6 pounds of copper sulphate in 16 gallons of water and slake 4 pounds of unslaked lime in 6 gallons of water. Stir the lime well, strain and pour slowly into the copper solution, stirring all the while. Do not pour the copper into the lime. Use only wooden or earthen vessels as the copper sulphate will corrode metals. The solution should be used as soon as made, as it loses strength from standing. Two ounces of either London purple or Paris green may be added to the Bordeaux mixture for the destruction of insects.

Potato Beetle.

Every potato grower is familiar with this common enemy and knows that either Paris green or London purple is an effective remedy. If applied dry use 1 pound of either thoroughly mixed with 10 pounds of flour or one-half pound with 10 pounds of either road dust or lime. If used in solution add one-fourth pound Paris green or 2 ounces of London purple to 25 gallons of water and keep well stirred while using.

Appendix.

Basing the food requirements of the Irish potato on 6 per cent ammonia, 7 per cent available phosphoric acid, 8 per cent potash, the North Carolina Experiment Station proposes the following special formulas for this crop. The ingredients are to be mixed and applied in quantities to suit:

1.	300 lbs. Nitrate Soda 600 lbs. Cotton Seed Meal 800 lbs. Dissolved Bone Black 300 lbs. Muriate Potash 2,000	will yield	5.4% Ammonia. 7.2 " Avail. Phos. Acid. 8.1 " Potash.
2.	300 lbs. Nitrate Soda 600 lbs. Fish Scrap 800 lbs. Acid Phosphate 14% 300 lbs. Muriate Potash 2,000	will yield	5.4% Ammonia. 6.8 " Avail. Phos. Acid. 7.8 " Potash.
3.	200 lbs. Nitrate Soda 900 lbs. Fish Scrap 600 lbs. Dissolved Bone Black 300 lbs. Muriate Potash 2,000	will yield	6.4% Ammonia. 6.6 " Avail. Phos. Acid. 7.8 " Potash.
4.	220 lbs. Nitrate Soda 500 lbs. Dried Blood 970 lbs. Acid Phosphate 14% 310 lbs. Muriate Potash 2,000	will yield	6.1% Ammonia. 6.8 " Avail. Phos. Acid. 8.0 " Potash.
5.	300 lbs. Nitrate Soda 600 lbs. Cotton Seed Meal 800 lbs. Acid Phosphate 13% 300 lbs. Muriate Potash 2,000	will yield	5.4% Ammonia. 6.0 " Avail. Phos. Acid. 8.3 " Potash.
6.	300 lbs. Nitrate Soda 600 lbs. Tankage 800 lbs. Acid Phosphate 13% 300 lbs. Muriate Potash 2,000	will yield	5.5% Ammonia. 6.4 " Avail. Phos. Acid. 7.8 " Potash.

C. L. NEWMAN.

Spraying Fruits.

Spraying has become a part of the successful fruit grower's duties. It has been demonstrated by experimenters and practical growers, that spraying fruit pays. There has been much written on the subject, enough so that all can be informed.

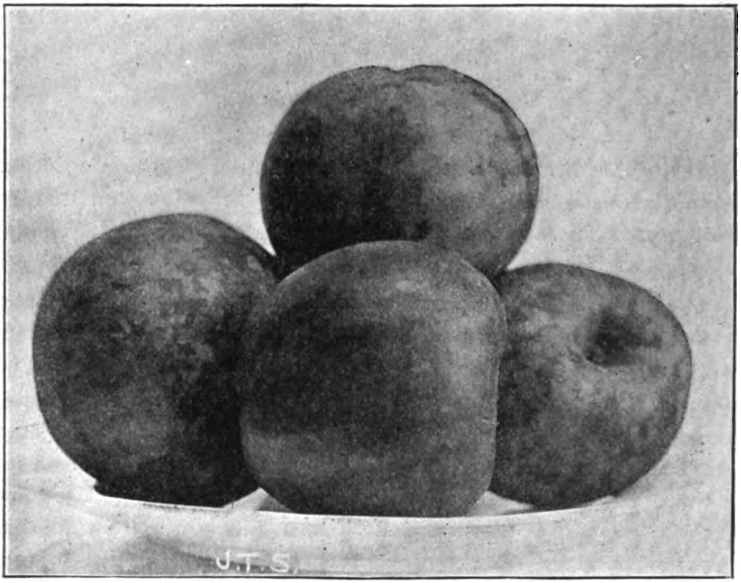
Apple Scab has been described, and experiments to prevent it, given in a previous bulletin of the Station. It has caused only a small amount of injury to the apple crop this year, as compared to the two previous years; the causes are probably the extremely dry weather in April, at the time that the spores of the fungus were gaining a foothold on the leaves and fruit. The small amount of rain in May and June had a tendency to still further check the disease. The excessive rainfall in July came too late to revive the fungus, and, as a result, the crop was nearly free from the disease. The results obtained from spraying this year are given under "Spraying Experiment.".

Bitter Rot was abundant in most sections; orchards that had not been injured by it before, were this year. The causes for the prevalence of the disease were probably the abundant rainfall in July, followed by a fair rainfall in August and September, accompanied by some hot weather during these months. In many sections there was considerable loss of fruit from this disease. The orchards located on the elevated portions were less affected. The results obtained from spraying this year are practically the same as those in previous work. There was much less bitter rot on the sprayed fruit than on the unsprayed. From the results obtained it is concluded that the injury can be partly prevented with three sprayings with Bordeaux mixture.

**Apple Skin-Blotch.* This disease is the cloudy or dark spots on the surface of the apples. Some kinds are more affected by it than others, especially some of the light colored varieties. The cloudy, dirty appearance caused by the disease injures the sale of the fruit, and causes such as would be classed as first to grade as second. The difference in price amounts to considerable. It is probable that all are acquainted with the disease, though it is more prevalent in some sections than others. It is less frequent in orchards on high lands, and is more common in central and southern portions of the State than in the northwestern. Spraying for apple scab this year with Bordeaux mixture prevented this disease. The

---

*As no common name for this disease was known, a samp'e of the diseased fruit was submitted to Professor L. H. Bailey, who has kindly suggested the name of Skin-Blotch.



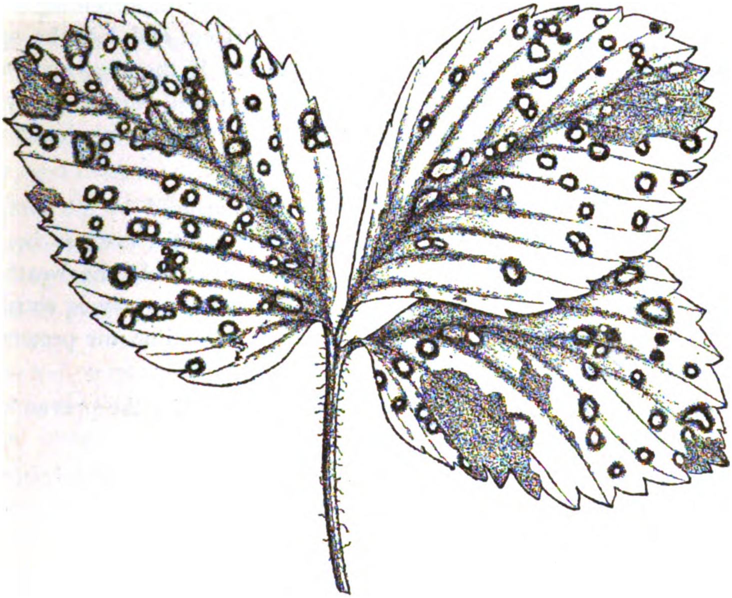
APPLE SKIN-BLOTCH.

sprayed fruit was bright and highly colored; the unsprayed dull in color, having this cloudy, dirty appearance. The results from the sale of some of the fruit are given under the "Spraying Experiment." The fungus was pronounced by Professor B. T. Galloway to be *Leptothyrum pomi*.

Grape Diseases. The vineyard was sprayed this year as usual, but owing to its having been sprayed previous years, only three applications were given; these were sufficient to prevent almost entirely any loss this year. Some varieties were damaged to some extent; these are mentioned in the notes on these varieties. Since spraying has come into general practice, many table varieties can be successfully grown that were almost a total failure before.

Strawberry Leaf-Blight. This is a fungous disease that affects the strawberry leaves and causes the brown spots or patches on them. It is also called strawberry rust by some. The disease does not generally appear until about fruiting time, when it appears as small, reddish spots, which increase rapidly in size, the center being of a lighter color. These spots often run together, forming large blotches; the affected leaves wither, turn brown and die. Some varieties are more affected by it than others, and this should be taken into consideration when selecting varieties for planting, as the disease seriously affects the vitality of the plant, and diminishes the crop the next year.

Spraying with Bordeaux mixture is successfully practiced in preventing this disease. The first spraying can be given early in the spring, after the new leaves start, and just before the blossoms open. The second soon after the fruit is picked, followed by two or three applications about two or three weeks apart.



*STRAWBERRY LEAF-BLIGHT.

The leaf-blight was successfully prevented by using Bordeaux mixture on a portion of the Station plots this year.

Causes of Failure from Spraying.

Spraying is sometimes reported a failure. This is due to several causes, some of which are given.

The Mixtures Not Properly Prepared. Too much care can not be taken in preparing any mixture to be used on trees and fruits. If not properly prepared, injury may follow. Bordeaux mixture, if properly prepared, will not injure the apple; but if there is not a sufficient amount of lime, injury may follow, causing the surface of the apple to be russeted and rough. Also damage to foliage may result. Other fruits are susceptible to injury from the mixture, if carelessly prepared. This mixture is one of the most effective fungicides in use.

Spraying is Not Thoroughly Done. This is often the cause of failure, and it is surprising that there are not more reports of failure. The work in many cases is so poorly done that only a small per cent of the surface of the trees is reached. The trees and fruit should be covered with the mixture. The application of a fungicide is for the purpose of preventing injury; therefore, it is necessary that it be on the surface, and kill the spores before they enter the tissues of the fruit or plant. If the spraying is carelessly done and the surface only partially covered the crop is only partly insured against attack. The same is true when spraying with insecticides for biting insects.

---

*This cut was kindly loaned us by Professor H. Gorman, of the Kentucky Experiment Station.

Spraying in Wet Weather. Failure is often caused by the spray not being applied at the right time. It is necessary that the mixture be kept on the plants whenever there is danger of infection. If the weather is rainy the mixture is liable to be washed off, therefore, the spraying should be repeated until the wet weather has ceased. At this time the presence of the mixture is most needed.

Directions for preparing and applying mixtures for the prevention of fungous diseases are found in Bulletin No. 26.

Descriptions of insects injurious to fruits, and remedies for destroying them are found in Bulletin No. 33.

Spraying Experiment.

The experiments in spraying apple trees were carried on in an orchard belonging to Mr. Kantz, who gave us the privilege of treating his trees, and assisted in the work.

The objects of the experiments were: First. To verify the results obtained in previous experiments in the prevention of apple scab. Second. The prevention of other fungous diseases. Third. The effect of spraying on the yield. Fourth. The effect of Bordeaux mixture on the foliage.

Three sprayings were given: The dates were May 3, 24, and June 21. The trees were divided into four plots: plot 1 was given two sprayings, the dates were May 3 and 24; plot 2, also two sprayings, dates May 24 and June 21; plot 3 was given all three sprayings on the dates above mentioned; plot 4, unsprayed trees left as a check. The variety was the Mammoth Black Twig. The trees are young and have borne but a few crops.

The apples were picked from the trees October 8. Only the fruit on the trees at this time was taken into account. No record was kept of the fallen apples.

Plot No. 1, sprayed May 3 and 24, free from scab, 90 per cent; scabby, 10 per cent. The results for the other two sprayed plots were practically the same concerning the amount of apple scab.

Plot No. 4, unsprayed trees, free from scab, 83 per cent; scabby, 17 per cent.

The results show very little more scab on the sprayed than on the unsprayed trees. There was very little scab in the orchard this year, as is seen by the amount of scabby fruit on the unsprayed trees.

From the results it would appear that the spraying did not pay as far as the prevention of apple scab is concerned; and, if this were to be considered alone, it might be so. It is known that spraying one year has its effects on the following year's crop. Spraying the fruit insures it against injury from disease, therefore, it pays to apply the fungicides as we are not sure of freedom from attack.

Apple Skin-Blotch. For the purpose of getting something definite on the selling qualities of the fruit free from this fungus, as compared with that injured by it, three barrels of apples were shipped to M. D. Garlington & Co., Dallas, Texas. Each barrel was numbered, and he was asked to sell each barrel on its merits. The fruit was the best we had of each class. Barrel No. 1 was from the unsprayed trees, barrel No. 2 was from the trees sprayed only the first and second times. The disease on this fruit had not been wholly prevented; the last spraying probably proved the most effectual in preventing the fungus. Barrel No. 3, from trees sprayed all three times disease wholly prevented.

The results were as follows: Barrel No. 1, $3; barrel No. 2, $3.25; and barrel No. 3, $3.50. This gives 50 cents a barrel more for fruit free from this disease over that injured by it. The apples in all three barrels were practically the same, excepting the presence of this disease to some extent on the fruit of barrel No. 2, and to considerable extent on that of barrel No. 1.

The effect of Bordeaux mixture on the yield is important. The results obtained this year are more marked than those for 1893. When the trees were selected there was no noticeable difference in the size of the trees and the amount of bloom. They all promised a good crop; all were the same age and had the same care previous to this year. The crop was light on all trees in the experiment plot; but the apples were all large. Those on the unsprayed trees did not average so large as those on the sprayed.

The average number of apples on each sprayed tree at gathering time was 194; the average number on the unsprayed trees was 63. This gives the yield from the sprayed trees over three times that from the unsprayed.

The trees that were sprayed presented a healthy appearance at the time that the fruit was gathered; the leaves were still on the trees and were green. The leaves on the unsprayed trees had nearly all fallen; those remaining were partly dead and the trees presented a bare appearance. The effect on the foliage was very noticeable.

The results from this year's work correspond closely with those obtained in 1893; they differ in the amount of apple scab, as it was very abundant that year. A probable reason why there is so much difference in the amount of scab is, that the orchards selected for the other experiment were old, in which the scab had caused almost the entire loss of the marketable crops previous years. The orchard sprayed this year was young.

For the purpose of comparison of results, some of the results of the former experiment are here given:

Results for 1893. (From Bulletin No. 26.)

The value of the fallen apples from the sprayed trees for evaporating and cider over those from the unsprayed trees, was more than enough to pay for the spraying, thereby leaving the increase of marketable apples due to spraying as profit.

The fruit from sprayed trees was practically free from scab and nearly twice as many apples were on them at gathering time as were on the unsprayed trees. From the experiments this year it is inferred that three or four sprayings are sufficient to prevent the scab. The trees sprayed but twice gave about the same per cent free from scab as those sprayed three times, but the apples were not so large as those sprayed three times.

The apples from sprayed trees were larger and more even than those from unsprayed, and the sprayed fruit was heavier.

The sprayed trees yielded an average of two and three-fourths bushels per tree of marketable apples, while the unsprayed trees averaged one and three-eighths bushels per tree, and only 35 per cent of it was marketable, or less than one-half bushel of marketable apples to the tree. The remaining 65 per cent was a poor grade of cider apples. The cost of spraying was 17 cents per tree, and the increase ot marketable apples was two and one-fourth bushels, making a cost of less than 8 cents per bushel.

Strawberries.

There are over one hundred varieties of strawberries growing at the Station. The list is added to at each new planting, and those considered worthless are discarded. Records of each variety are kept; these contain the amount of yield, the relative healthfulness and vigor of the plants, time of blooming and the ripening of fruit.

Strawberry growing in the State is demanding considerable attention, especially in certain sections. For the purpose of securing more definite information regarding varieties, trial grounds have been set at Fort Smith and Camden. It is the intention to have trial plots of the leading varieties at other points in the State. By this means more reliability can be put in a report on varieties; the new ones of promise can be secured, tested and reported on before they are purchased by growers. It is well known that little reliability can be put in a variety test from one section only. Better results can be obtained where a variety is tested in several different locations. For this reason the results obtained from the tests here will not be published in full, until they are published in connection with those from other sections of the State.

A few brief notes of some of the leading varieties are given. In the notes given the pistillate, or imperfect flowering varieties, are marked (P); the perfect flowering, or bisexual, are marked (B). Some of our best and most productive kinds are pistillate, and will not produce fruit unless some perfect flowering variety is planted near by. Care must be taken in planting that there be at least one row of bisexual for every three or four rows of pistillate. Some of the perfect blooming varieties are better pollen producers, and bloom over a longer period than others; these should be selected. The time of blooming is also important; varieties blooming about the same time should be planted near each other. The dates of the first picking are given with other notes, for fifteen varieties.

Barton's Eclipse (P) May 9. Stand good; plants small to medium; light in color; productive; fruit large, form and color resembling Haverland. It promises to be a good market berry for some sections of the State; has been planted quite extensively at Judsonia.

Bedar Wood (B) May 9. Stand good; plants small; rather dark; slightly damaged by rust; yield good; berry small to medium, but smooth and even; flavor good; is desirable as a pollen producer; also yields a good crop.

Bubach No. 5 (P) May 11. Stand fair; strong plants; inclined to grow in clumps; yield fair to good; produces large crops where it is given high culture. It is planted to some extent at Fort Smith as a market berry.

Crescent (P) May 8. Stand good; plants strong; productive; yield good. This berry is more extensively grown for market in this State than any other variety.

Eureka (P) May 11. Stand very good; plants light color; yield good. It set a very heavy crop, but matured only halt of it.

Enhance (B) May 11. Stand good; leaves small to medium; rather light color; plants vigorous; fruit large size; firm, good color. It is promising for this section.

Gandy (B) May 16. Stand good; plants strong; yield good; berries large and even. It is a desirable late berry; may be relied upon to produce good crop.

Haverland (P) May 11. Stand fair; plant strong; foliage dark; yield good; berry good size, and vaulable for market. It should have good care and rich soil for good results.

Meek's Early (B) May 7. Stand very good; plants strong; large leaf, and rather dark color; yield good, but not so good as Michel; berry about the same size; solid, and will stand shipping well. It is a desirable early berry.

Michel's Early (B) May 7. A good stand of vigorous plants; yield good. It is the best early market berry on the grounds, as it matures the main crop early, when berries bring good prices; is a good pollen producer, and is extensively used as a fertilizer. This berry was originated by J. G. Michel of Judsonia.

Parker Earle (B) May 11. A fair stand of strong plants, inclined to grow in clumps; yield good; it set a very heavy crop, but did not mature all of it; berry large.

Shuster's Gem (B) May 8. Stand good; plants large and strong; rather dark color; yield good: berries large and of good color. It is promising, and deserves further trial.

Stayman's No. 1 (P) May 11. Plants strong and a good stand; yield extra good; berry a little larger than Crescent; promising.

Warfield No. 2 (P) May 9. Stand medium to good; plants healthy; inclined to grow in clumps: yield good; berry larger than Crescent and more firm.

Woolverton (B) May 11. Stand good; plants strong; large leaf; yield good. It is a good pollen producer, and remains in bloom a long time; it is a good variety to plant with pistillates.

Varieties that seem to have considerable value, and have done fairly well here; some of them are old varieties, others new. The newer ones will be tested further. These varieties have some special points of value, but not enough to recommend them for general planting.

Beverly,
Burt's Seedling,
Clark's Early,
Cloud,
Crawford,
Cumberland,
Gov. Hoard,
Great Pacific,
Hoffman,
Lady Rusk,
Lovett,
Leader,
Martha,
Mrs. Cleveland,
Muskingum,
Sandoval,
Saunders,
Sharpless,
Standard,
Swindle,
Van Deman,
Wilson.

Varieties that have little to recommend them. Some of them will be given further trial, and reported on again.

Accomac,
Acme,
Alabama,
Auburn,
Edward's Favorite,
E. P. Roe,
Farnsworth,
General Putnam,
Pearl,
Pineapple,
Price,
Princess,

Beebe,
Bessie,
Bidwell,
Bomba,
Dayton,
Dew,
Edgar Queen,
Gillespie,
Gypsie,
Jessie,
May King,
Middlefield,
Monmouth,
Oregon Everbearing,
Regina,
Shaw,
Sterling,
Stevens,
Tippecanoe,
Walton,
Westbrook.

New varieties that have not fruited here. This list will be added to, and other new varieties will be planted next spring.

Arrow (P),
Brandywine (B),
Bisel (P),
Belle (P),
Belmont (B),
Cyclone (B),
Columbian (B),
Chairs (B),
Enormous (P),
Gandy Belle (B),
Greenville (P),
Ivanhoe (B),
Jay Gould (B),
Mineola (B),
Princeton Chief (P),
Paris King (B),
Rio (B),
Robinson (P),
Splendid (B),
Tennessee Prolific (B),
Timbrell (P).

Reports on some of the leading varieties, from a few localities in different sections of the State.

Arkansas County, Goldman. R. E. Lynch. After testing about sixty varieties have settled down to Hoffman's Early, Van Deman, Haverland, Bubach No. 5, Barton's Eclipse, Eleanor and Gandy Prize.

Boone County, Harrison. G. A. Gamble. The best varieties for this section are Lady Rusk, Michel's Early, Crescent, Sharpless, Bubach No. 5 and Warfield No. 2.

Crawford County, Van Buren. M. F. H. Smeltzer. The varieties giving the best results in this section are Crescent, Michel's Early, Smeltzer's Early No. 2, Gandy Prize and Bubach.

Drew County, Monticello. S. J. Mathews. Those doing the best are Michel's Early, Crescent, Bubach, Haverland, Wilson, Parker Earle and Cumberland.

Fulton County, Mammoth Spring. D. S. Helvern. Those giving the best results are Crescent, Parker Earle, Sharpless, Bubach No. 5, Greenville.

Jefferson County, Pine Bluff. Wm. T. Simpson. Bubach, Haverland, Greenville, Michel's Early and Gandy. These varieties are given in the order of their popularity as a near-by market berry.

Lonoke County, Austin. Geo. P. Murrell. Varieties giving best results Michel's Early, Crescent, Bubach and Cumberland.

White County, Judsonia. A. M. Kittler. The varieties giving the best results with me are Michel's Early, Crescent, Arkansas Traveler and Warfield No. 2.

Grapes.

Nearly all the varieties of grapes growing in the Station vineyard are described below, also the yield for this year and character of vine are noted. Some did not bear a crop and the growth of vine indicates that they are not adapted to this section.

The abbreviations for the different botanical classes are given italicized and in parenthesis.

Lab. for Labruska, the Northern Fox grape. This is a native of the Alleghany Mountains, and it comprises a large portion of our cultivated grapes.

Rip. Riparia, the wild grape of the river banks. It has a wide distribution and is found growing wild in most all sections.

Æst. Æstivalis, is the well known summer grape.

Linc. Lincicumia, its the Texas Post Oak grape.

The Rotundefolia class is the Southern Fox grape, the most prominent variety being Scuppernong. This grape does well in Southern Arkansas and should be extensively planted. It will not bear in this section.

Agawam. (*Labr.-Hybr.*) Rogers' No. 15. Vine vigorous, a good grower and moderately productive; bunch medium to large shouldered; berry large, skin thick; pulp fairly tender, sweet and good. This is a desirable grape for further trial. Yield fair to good.

Amanda. (*Labr.*) Vine a very strong grower; foliage healthy; bunch large, very compact, shouldered; berry large, black with blue bloom; skin thick; pulp very hard, and rather poor flavor. It bears a heavy crop, but is not desirable owing to the poor quality of the fruit. Yield good to very good.

Amber. (*Rip. Labr.*) Vine good to very good, moderately productive; bunch medium, rather long; berry medium to large, oblong; color pale amber; skin thin, flesh tender, sweet and fine flavor. A good grape for the garden, but not profitable for the market as it is too tender to stand handling. Yield fair.

Amber Queen. (*Labr. Hybr.*) Vine good grower, but only fairly productive, owing to its not being fully self-fertilizing; bunch medium shouldered, not well filled; berry large, purple colored, and nearly black when fully ripe; flesh tender, rich, flavor very good; season August. It is not desirable unless planted near a variety that will fertilize it. Yield poor.

Aminia. (*Labr. Hybr.*) Rogers' No. 39. Vine medium grower, productive; bunch large, sometimes shouldered, berry large, dark purple, nearly black with bloom; flesh tender with little pulp; flavor very good. Season last of July and first of August; a few days later than Hartford. It deserves further trial, and promises well for a table grape. Should be planted near some variety that blossoms at the same time, to fertilize it. It is a promising, early grape. Yield fair to good.

Arkansaw. (*Labr.*) Vine vigorous grower; foliage healthy; bunch large shouldered and moderately compact; berry large, larger than Concord, oval; color a peculiar bronze with a bloom; flesh tender, sweet; flavor good. The berry hangs well on the stem, is a good shipper; it has a characteristic fragrance that distinguishes it.

It resembles in color, flavor and fragrance a grape that I saw in Mr. Herman Jaeger's exhibit at the Neosho Fair in 1892, called by him Well's Seedling.

It is introduced by Mr. Joseph Hart of this place.

August Giant. (*Rip. Hybr.*) Vine strong grower, and fairly productive; foliage healthy; bunch large, sometimes shouldered; berry large, black. Yield fair.

Bacchus. (*Rip.*) A seedling of Clinton. Vine a very good grower; bunch small to medium, compact and shouldered; berry small, black with blue bloom, juicy; flavor sprightly. Season August. It is probably a desirable wine grape. The crop was damaged considerably by black rot. Yield good.

Barry. (*Labr. Hybr.*) Rogers' No. 43. Vine vigorous and a good grower; bunch large, handsome, shouldered; berry large, black; flesh tender and pleasant; skin thin; season about ten days earlier than Concord. It is not superior to other black grapes ripening at the same time, but deserves further testing. Yield fair.

Berckmans (*Rip. Hybr.*) This is a cross between Clinton and Delaware. Vine vigorous and moderately productive; bunch small, shouldered; berry about the size of Delaware and larger; color and flavor closely resembling it, but flavor not equal to it. The vine is a much stronger grower than the Delaware, but the yield is not so large per vine. It is not probable that it will take the place of the Delaware. Yield fair.

Black Pearl. (*Rip.*) Vine vigorous and productive; bunch medium, compact, shouldered; berry medium, black; skin tough; season August. A good wine grape. Yield good.

Black Eagle. (*Labr. Hybr.*) Vines weak, making a poor growth, no crop this year.

Brilliant. (*Labr.-Hybr.*) A seedling of Lindley crossed by Delaware, originated by T. V. Munson, Denison, Texas. Vine good, strong grower, and productive; foliage healthy; bunch large, shouldered and of fine appearance; berry large; skin thin but tough; color closely resembles the Delaware, but brighter; ripens about the same time. This variety may prove a valuable market berry. It is much larger in bunch and berry, stands shipping better, and is nearly equal to the Delaware in flavor. It is the most promising new grape on the grounds for the table and for the market. Yield good.

Cambridge. (*Labr.*) Vine good grower; bunch large, shouldered; resembles Concord in bunch and berry, but berry slightly smaller and covered with a heavy bloom; quality about the same as Concord; season a few days earlier; yield the same.

Catawba. (*Labr.*) Very vigorous, productive; bunch large, shouldered, moderately compact; berry medium to large, red covered with bloom; season, last of August and first of September; yield fair to good.

Centennial. (*Æst. X Labr.-Hybr.*) A seedling of Eumelan crossed on some Labrusca grape; vine a fair grower; bunch medium, compact, shouldered; berry small to medium, color amber when fully ripe; skin rather tough, but little pulp, juicy and sweet; ripens with the Concord. A very finely flavored grape, and would be very profitable if the vine were a strong grower. Yield fair.

Champion. (*Labr.*) Vine good to very good; bunch large, compact and shouldered: berry medium to large, black; skin thick, quality fair; season last of July and first of August, As there are better early grapes than this one, ripening about the same time, its good yield is all that can recommend it.

Clinton. (*Rip.*) Vine very good, strong grower; bunch small; berry small, black with blue bloom; skin thin but tough, flesh juicy; flavor somewhat acid. Season September. This is not a desirable grape for this section where better grapes can be grown. Some of the fruit rotted before gathering time. Yield poor.

Concord. (*Labr.*) Vine very good; bunch large, shouldered; berry large, black, thickly covered with blue bloom; skin thin; flesh sweet, pulpy and tender; season August. Fairly productive. This is one of the most popular market grapes, and is grown more extensively than any other variety in this country; but does not do so well here as further north.

Conqueror. (*Labr.-Hybr.*) Vine good grower; bunch small, long and rather loose, shouldered; berry small, black with bloom; flesh juicy and very sweet; season last of August and first of September; yield fair.

Cottage. (*Labr.*) A seedling of the Concord; vine a strong grower and productive; bunch medium to large, shouldered; smaller than Concord, but more compact; berry large, black, heavy bloom; skin thick; flavor resembles Concord somewhat; begins to ripen about one week earlier; yield good.

Creveling. (*Labr.-Hybr.*) Vine poor grower; no yield this year.

Cunningham. (*Æst.*) Vine good and strong; bunch medium, very compact, rather long; berry small, nearly black, covered with bloom;

juicy and sweet; season September; yield poor to fair; grapes rotted badly before gathering time.

Cynthiana. (*Æst.*) Vine very strong grower, foliage healthy, bunch medium, moderately compact, shouldered; berry small to medium, black with a blue bloom; flesh tender, sweet; season September. It is one of our surest grapes for a general crop, and is probably the best red wine grape; yield good.

Delaware. Vine only a moderate grower; foliage healthy and fairly productive; bunch small to medium, shouldered, compact; berry below medium in size; color light red covered with a white bloom; skin thin; pulp sweet and tender, flavor best. The peculiar, delightful flavor is not equaled by any other variety in the vineyard. Yield good.

Devereux. (*Æst.*) Vine good strong grower; bunch small, shouldered; berry small, black; flesh tender, juicy and sweet; flavor pleasant. A good wine grape, but subject to rot. Yield poor.

Diana. (*Labr.*) Vine good; bunch medium, compact; berry medium; color pale red with a thin bloom; flesh tender, sweet and juicy. Season September. Yield poor.

Dr. Warder. (*Labr.*) Cuttings received from Department of Agriculture at Washington. Vine good, vigorous grower, foliage healthy; bunch medium, shouldered; berry medium, black; flesh tender, juicy and sweet; skin thick; berry hangs on to the stem well. Season first of August. It is deserving of further trial.

Dracut Amber. (*Labr.*) Vine good grower; bunch large, shouldered; berry large, round; color pale red; skin thick; flesh pulpy and flavor foxy. Yield fair; not desirable.

Duchess. (*Labr.-Hybr.*) Vine good, strong grower, foliage healthy; bunch medium, shouldered, compact; berry medium; color greenish white, turning to a light yellow when ripe; skin rather thick; flesh tender, free from pulp; excellent flavor. Yield fair. There are other white grapes ripening about the same time, mentioned elsewhere that are better; ripens with the Concord.

Early Golden. (*Labr.-Hybr.*) Produced by T. V. Munson and originally named "Campbell," but since changed by him to the present name. Vine fair grower and moderately productive; bunch large and well filled, shouldered; berry medium to large; color from a whitish to a golden; skin thin, no pulp; promising table grape. Season August. Yield fair.

Early Ohio. (*Labr-Hybr.*) A chance seedling from Ohio, sent to the Station in 1892. Vine vigorous, foliage healthy; bunch large, shouldered; berry medium to large; color black with a heavy bloom; flavor much better than the other early black grapes. It was one of the first to ripen its fruit this season, and it promises well for an extra early grape.

Eaton. (*Labr.*) A seedling from the Concord. Vines have made a poor growth, no crop on them this season.

Elvira. (*Rip.-Hybr.*) Vine good, strong grower; bunch medium, very compact, shouldered; berry medium to large; color pale green with a white bloom, tinged with red when fully ripe; skin thin; pulp tender, sweet and juicy. Season last of August and first of September. Yield good.

Etta. (*Rip.*) Vine fair to good grower; bunch medium, compact, but not so compact as Elvira; berry medium to large; color greenish yellow covered with a white bloom; flesh tender, flavor good. Yield poor to fair.

Faith. (*Rip. X.*) Vine good grower, only fairly productive; bunch medium, shouldered; berry medium; color yellowish white; flavor very good, juicy. Yield poor.

Gœthe. (*Labr.-Hybr.*) Vine vigorous; bunch large, not compact, shouldered; berry large to very large, oblong; color pale red to red when fully ripe; skin thin but tough; flesh tender, juicy, with a peculiar, desirable flavor. Season September. Yield very light.

Golden Gem. (*Æst.-Hybr.*) Vine medium grower, but not productive; no crop this year.

Green Mountain. (*Labr.*) Vine medium grower, very productive; bunch medium, shouldered; berry medium, color greenish white; skin thin; pulp tender and sweet, delightful flavor; season last of July; yield good; promising.

Grein's Golden. (*Rip.-Hyb.*) Vine poor to fair; bunch medium, shouldered; berry large, color yellowish green; flesh tender; flavor very good; yield very poor; not desirable.

Hartford. *(Labr.)* Vine good, strong grower and productive; foliage healthy; bunch large, some very large, shouldered; berry medium, black; flesh pulpy, juicy and has a perceptible foxy flavor; season last of July; yield extra good.

Herbemont. (*Æst.*) Vine extra strong grower; bunch large, long, compact and shouldered; berry small, color black with a blue bloom; skin thin; flesh sweet, no pulp; season September; yield poor; rotted badly on vines.

Herbert. (*Labr.-Hybr.*) Rogers' No. 44. Vine fair to good grower; bunch large, shouldered, not well filled; berry very large, black; flesh sweet and excellent flavor; a fine showy grape; yield poor.

Hermann. *(Æst.)* Vine extra fine grower; bunch long, narrow and compact; berry small, black with a blue bloom, moderately juicy; a good wine grape; yield good.

Hermann Jaeger. *(Æst. X. Linc.)* Another of Munson's productions, the result of crossing Herbemont on a native wild grape. Vine vigorous and very productive; bunch large, shouldered, compact; berry medium to large; color dark purple to almost black, with blue bloom; skin thin but tough; quality good, pulp tender and juicy; season September; yield very heavy. It is a very promising variety, as it combines good quality and wonderful productiveness. It gave the largest yield of any variety in the vineyard.

Highland. (*Labr.-Hybr.*) Vine fair to good grower; bunch very large, shouldered, not compact; berry large, black with blue bloom; flesh tender, very little pulp, juicy, sweet; season September; yield poor.

Iona. (*Labr.*) Vine good grower and productive; bunch large, shouldered; berry medium to large, color a yellowish green with a slight purple cast, with bloom; flesh tender, sweet, quality best; season September; yield good.

Ironclad. (*Rip. X. Labr.*) Vine vigorous; bunch small, compact; berry small, black, pulpy, flavor good; desirable for a wine grape, but not suited either for market or the table.

Isabella. (*Labr.*) Vine vigorous, but only fairly productive; bunch medium to large, loose and not well filled; berry large and nearly black, covered with a blue bloom; flesh juicy, pulp and skin tough; yield poor; not desirable.

Israella. (*Labr.*) Vine a good grower; bunch large, shouldered, compact; berry large to very large; skin thick, flesh pulpy, quality fair; yield poor.

Ives. (*Labr.*) Vine very vigorous; bunch medium, compact; berry medium, black; flesh pulpy and of a foxy flavor; not a desirable table grape, but popular as a wine grape, as it is unusually free from disease.

Janesville. (*Labr? X. Rip.*) Vine fair grower and productive; foliage healthy; bunch medium, short, compact; berry medium, black; skin thick, flesh pulpy; season last of July; yield good. It is poor in quality, but in the absence of a better grape would be desirable for early market.

Jefferson. (*Labr. X.)* Vine vigorous, but not productive; bunch large: shouldered; berry medium to large; color pale red, with bloom; flesh tender, juicy, sweet; flavor very fine; yield poor.

Lady. *(Labr.)* Vine poor; no yield this year.

Lady Washington. (*Labr.-Hybr.)* Vine vigorous; moderately productive; bunch large; shouldered; berry medium to large; color greenish yellow, with slight pink coloring where exposed to the sun; white bloom; flesh tender and sweet; good quality; season with Concord; yield fair.

Lindley. *(Labr.-Hybr.)* Rogers' No. 9. Vine vigorous; bunch medium to large; shouldered; not compact; berry large; color red; flesh tender: skin tough; flavor pleasant. It should be planted near another variety blooming at the same time to insure a yield.

Martha. *(Labr.)* Vine poor; yielded no crop this year,

Mary Ann. (*Labr.*) Vine vigorous; bunch medium, shouldered; berry medium to large; black, pulpy and of foxy flavor: very early, ripening with Hartford; quality poor. The other early grapes are better in quality and yield.

Maxatawney. (*Labr.*) Vine fair, not productive; bunch medium; berry large; color pale yellow; flesh sweet, no pulp; flavor good; yield poor; not desirable.

Merrimack. (*Labr.-Hybr.*) Rogers' No. 19. Vine weak; bunch medium; berry large; bunches not well filled; yield poor; not desirable.

Missouri Riesling. (*Rip. X*) Vine very vigorous; bunch medium, shouldered; berry medium to large; color greenish white, with a yellowish cast when fully ripe; flesh tender, sweet; season August; yield good; considerable fruit rotted before fully ripe.

Montefiore. *(Rip. X.)* Vine fair to good; bunch small, medium, compact, shouldered; berry small, medium, black, with blue bloom; skin thin; flesh tender, sweet, with a delicious flavor; season with Concord; yield good.

Moore's Diamond. (*Labr. X.*) A seedling of Concord, fertilized by Iona. Vine vigorous, productive; foliage healthy. It is a much better grower than Moore's Early. Bunch large, compact, shouldered and of handsome appearance; berry medium to large, greenish white, with bloom; flesh tender, juicy and sweet; skin thin; a delightful, refreshing flavor; season August. It is a desirable early white grape, especially for home market; yield good.

Moore's Early. (*Labr.*) Vine fair to good; foliage healthy; bunch large, sometimes shouldered; berry large, color black; flavor very good; resembles the Concord closely, and has been appropriately called an "Early Concord." In quality it is much better than the other early black grapes in the vineyard; fruit cracks some when fully ripe; a good early grape for home market; ripens with Hartford; yield good.

Noah. (*Rip. X.*) Vine vigorous and productive; bunch medium, shouldered, fairly compact; berry medium to large; color greenish yellow; skin thin; flesh tender; moderately juicy; quality excellent; season September. It is promising for this section; yield extra good.

Norfolk. (*Labr.-Hybr.*) Vine very vigorous; foliage healthy; bunch large, shouldered, of handsome appearance; berry medium to large, purple with bloom; skin tough: a slight Muscat flavor; quality good. It promises to be desirable, owing to its time of ripening, which is one week after Hartford; yield good.

Norton's Virginia. (*Æst.*) Vine vigorous, and productive; fruit resembles Cynthiana so closely that it need not be described here. It is a desirable grape for this section. Season same as Cynthiana; yield good.

Perkins. (*Labr.*) Vine vigorous and moderately productive; bunch medium to large, shouldered; berry medium to large, color pale red when fully ripe, with bloom; flesh pulpy, sweet; flavor fair, foxy; it is free from disease and generally productive; season a few days later than Concord.

Pocklington. (*Labr.*) Vine poor to fair, and not very productive; bunch large, only fairly compact; berry large to very large, yellowish green with a heavy white bloom; fine appearance; flavor good, resembles Concord, but better. It is not promising for this section.

Rentz. (*Labr.*) Vine vigorous, moderately productive; bunch large, compact, shouldered; berry large, black; flesh pulpy, sweet; flavor only fair, somewhat musky; skin thick; yield fair; not desirable.

Rogers' No. 2. (*Labr. Hybr.*) Vine vigorous; bunch large, but not well filled; berry extra large, dark purple, thick skin; yield poor; not desirable.

Rommel. (*Rip. Hybr.*) Vine very strong grower; foliage fairly healthy; bunch medium, compact; berry medium, large, greenish white, skin thin; pulp tender, flavor good; season August. It is one of Munson's productions, and may prove desirable on further trial; yield fair.

Taylor. (*Rip. X.*) Vine good; bunch small, compact; berry small, pale amber; no pulp; yield poor; not desirable.

Telegraph. (*Labr.*) Vine vigorous, moderately productive; bunch medium, compact and shouldered; berry medium, black with blue bloom, little pulp, juicy, good quality; season a week later than Hartford; yield fair to good.

Transparent. (*Rip. X.*) Vine a strong grower; bunch small, compact and shouldered; berry medium, greenish yellow, skin tough; no pulp; flavor good; yield poor.

Triumph. (*Labr. X. Vin.*) Vine fair to good grower; bunch extra large, compact, shouldered, and of fine appearance; berry large, greenish yellow, with bloom; skin thin; flesh tender, sweet; quality very good; yield poor.

Vergennes. (*Labr.*) Vine poor, no crop this year.

Wilder. (*Labr.-Hybr.*) Rogers' No. 4. Vine good grower; bunch large and shouldered; berry large, dark purple to black; flesh fairly tender, sweet; season August; yield fair. It should be planted near some variety blossoming at the same time.

Woodruff. (*Labr.*) Vine fair grower; bunch medium; berry large, nearly black; ripens with Concord; yield poor.

Worden. (*Labr.*) Seedling of the Concord. Vine good, strong grower; bunch large, compact and handsome; berry large, black; flesh tender, resembles Concord; skin thin and tender; yield good. It has done better here than the Concord.

Wyoming Red. (*Labr.*) Vine medium to good grower; foliage healthy; bunch medium, shouldered; berry medium, red; skin thin, flesh sweet, foxy; yield good.

JOHN T. STINSON,
Horticulturist.

INTRODUCTORY.

R. R. Dinwiddie.

This bulletin contains a brief report of certain experimental work which has been carried on at the experiment station, a reference to the most important of the several outbreaks of disease in farm animals which have been investigated during the past year with some suggestions arising from the same, and the report of Dr. H. V. Goode on his investigations of diseases of hogs and other animals during the months of September, October and November of last year.

The investigations of diseases of farm animals carried on in other parts of the State are made on the request of responsible citizens of the locality where the disease occurs, and only after satisfactory evidence that the outbreak is of sufficient magnitude and importance to justify the expenditure which such an investigation involves. This explanation is needed in so far as frequent letters are received here requesting a personal examination when the disease in question is limited to only one or two animals. In cases of this kind the requisite information can best be given by mail, and all such communications will be answered in this way.

On the Toxic Properties of Molds.

In a previous bulletin (No. 25) an account was given of an experiment made in the feeding of horses with molds such as are commonly found on corn, oats, and hay when imperfectly cured. It was sought to test the correctness of the common belief that the mold occurring on damaged corn especially was the cause of the horse disease usually called "staggers." The negative result of that test induced me to repeat the experiment in the winter of 1895. A similar result was obtained as in the previous case; the two animals tested were apparently entirely unaffected by the comparatively large amounts of the molds fed to them.

As further investigations in this direction will probably be made in the future, the results of these tests being to my mind still unsufficient to outweigh the mass of positive evidence derived from common observation, the details of these experiments seem worthy of being put on record.

One animal, a colt two years old, was fed for three weeks with the worst ears picked out from a lot of badly molded and worm-eaten corn. About twelve ears of this were consumed daily (along with hay).

January 3, 1895, feeding with artificial cultures of molds was commenced. These cultures were made on wheat bran which was first mixed with water and cooked. Shallow tin dishes 6 to 10 inches in diameter were filled to a depth of 1 or 2 inches with this material and the surface seeded by rubbing it over with a moldy ear of corn. A mixed growth was generally obtained of the molds represented on the corn, these showing when fruited a black growth (*Mucor*) a green (*Penicillium*), and a pink referred to in a previous report. The two latter are the most common fungus growths found on damaged corn as we see it in the fields and cribs in this State. After from one to three weeks, when the surface was covered and spores abundant, the whole was thoroughly mixed with dry bran and thus fed. A diet of this amount and character was consumed twice daily from January 3 to March 1, good hay being also supplied. The relative proportion of the molds in question varied in each culture, but all three were fed in quantities much greater than would be obtained by the use of corn however badly damaged.

In a second colt of the same age the feeding of badly molded corn was kept up for six weeks after which, on January 23, pure cultures of the green pencil mold (*Penicillium glaucum*) grown as above described were substituted. This was fed in the same doses as before up to March 1, five weeks.

Although closely observed during the continuance of these tests there is nothing to record as to the effect except the apparent harmlessness of this diet.

These experiments are recorded merely as a contribution to the scientific investigation of this practically important subject, of which but little is known. The advice in regard to the feeding of unsound corn given in a previous report (Bulletin 25,) is yet to be recommended.

Texas Cattle Fever in Various Localities.

Limited outbreaks of this disease occurred in several parts of the State during the summer. The greatest losses were sustained on the ranges east of Little Rock on the route of the Little Rock and Memphis Railway. In one district visited there during July the loss was said to be about 500 head. In one or two other places a considerable number of cattle died but in most instances the reports give a comparatively trifling loss. The difference in this respect depends on the extent of the pastures over which cattle are allowed to graze, and on the number of cattle in the neighborhood. Where the range is large, and the disease introduced early in the summer, the loss of cattle is always great as the disease is practically beyond control except by the removal of all cattle from these pastures during the whole summer. The infection may at first be confined to a small area, but later it is distributed over the whole range. This is the history of the outbreak referred to in St. Francis County. In these central counties of the State, it is as a rule, unsafe to move cattle even for short distances, except in winter or late in the fall. So far as could be learned, the infection in this instance was probably introduced by cattle brought in spring from further South, and the disease appeared with the hot weather of June. The land being practically unfenced, every opportunity was afforded for the mixing of cattle and consequently for the unimpeded spreading of the disease.

An outbreak of Texas Fever with a somewhat similar history occurred in Woodruff County. Others reported were of less importance and confined to a small number of cows in several towns. The outbreak of Texas Fever which occurred in Fayetteville in August and September of last year may be cited here as an example, so far as history and results are concerned, of the disease as it is seen mostly in this State. The following report made at that time with the advice it contains can be applied to nearly all such cases:

The disease which is now prevailing among cattle in this city is that known as Texas or Southern Cattle Fever. It has most likely been brought here some time during the summer by cattle driven in from south of the mountains, or it may have started from droppings from stock cars passing through from the South. The infection is now probably distributed all round the town where cattle have been roaming, but the parts to the north and east of the city limits appear to be the most dangerous.

When outbreaks of Texas Fever occur in the northern part of this State during the summer the disease usually lasts until cold weather, gradually becoming milder in character. The infection is at present confined to the open or unfenced land around the city. To prevent it spreading to adjoining farms, and to diminish the number of cases in town the following suggestions are offered:

Farmers in the neighborhood of town should not allow their cattle to get on the roads or open grounds where town cattle have been grazing, and should not bring on to their farms any cattle which have been grazing about town even if quite free from disease.

Town cattle, for the next two months or until frost, should be kept up. Where they have been exposed and have ticks on their bodies, these should be removed (and killed) by grooming and washing thoroughly with kerosene emulsion,—one part coal oil made into an emulsion by rapid stirring with five or six parts of strong, hot soap suds.

The acute disease begins with a high fever which can be detected by feeling the horns and ears. Milder forms are also common and often cause temporary unthrift only.

Treatment is often unsuccessful in acute cases, but if taken in time a certain percentage can be saved. Sick cattle should be kept in the shade; they should be groomed thoroughly once, and washed several times with the emulsion referred to above. One-half to an ounce of quinine should be given during the first day and one-fourth as much on the following days for a week. Dead cattle should be buried deeply or burned.

In the counties further south in the State where there is more uncertainty as to the source of infection, and especially in those districts where the cattle are kept on large open ranges, the prevention of the introduction of Texas Fever and also of its extension is more difficult.

All movement of cattle for any distance in those districts ought to be made in late fall or winter. Previous experience should be the best guide as to the particular regions from which danger is to be feared. If cattle brought from a certain county have been found to bring disease, or rather infection, with them in one year, it may be inferred that the same thing will occur again under the same conditions. Hence, any one who buys up cattle at some distance from his own farm, should inquire as to the history of previous movements of cattle from the locality in question. If cattle must be brought in during summer, it would be advisable to keep them in a field by themselves along with two or three of the home stock for at least six weeks to observe the effect on the latter, before giving them full range.

It may be repeated here what most stockmen of experience probably know, that the healthy appearance or otherwise of a bunch of cattle furnishes no indication as to their capability of infecting home cattle with Texas Fever.

When the disease has broken out in any locality among home-raised stock, the only thing that can be done is to locate as near as possible the field or part of the range on which the cattle seem to get the disease, and then keep all cattle away from that place during the summer. To be of much use, this has to be done early. Still better—and this is the only real safeguard—would be the more general use of good fences, so as to prevent the indiscriminate mixing of cattle. Each farmer would then have the control of this disease in his own hands.

Report of Dr. H. V. Goode.

Texas Fever in Woodruff County.—Augusta, October 5. The town cows that range to the northeast are the only ones that have died. The number lost is twenty-five. I could get no history of infection. There are none sick in Augusta at the present time.

Snapp—Three years ago a man living near Snapp bought several Texas ponies out of a herd and turned them in with the cattle. In about two months his cattle began to die. Not knowing the cause, he decided to change pasture, so he turned the cattle outside. Several of the neighbors' cattle died that summer. The next summer a good many cattle died that pastured where the infected cattle ranged the year before. This last summer and fall, a large number of cattle have died. The infected range includes at least all of the township in which Snapp is. All of the cattle that have ranged outside have died. Cattle that pastured on overflow land are exempt from the disease, as there are very few ticks, and outside or infected stock do not range so far.

Post Mortem No. 1—fifteen months old steer.

Heart congested at apex; an excess of fluid in pericardial sac; liver much enlarged, very dark and easily broken down; spleen enlarged about four times; blood not coagulated in spleen; kidneys very dark and friable; bladder distended with colorless urine.

No. 2—Yearling Jersey, male.

Fair in flesh; blood very fluid; spleen enlarged at least six times and very dark; liver enlarged and friable; gall bladder contains about a pint of flocculent bile, very thick; bladder full of red urine; kidneys enlarged and very dark and soft.

No. 3—Cow six years old, had been sick two days.

Blood very fluid; liver would have weighed 20 pounds, spleen about 6 pounds; gall bladder contains at least a pint of a thick, dark bile; heart very much congested; much fluid around the heart; bladder full of water almost as thick as blood.

Suspected glanders in horses at Lonoke—The country around Lonoke is flat and sandy. The prairies are not fenced and stock turned on them are fed nothing even in winter, consequently horses become very poor and are subject to catarrhal troubles. A great many horses die every spring, as the winter leaves them too weak to withstand the spring changes.

A great many horses here have chronic catarrh, some of the cases being of five years' standing. The history of these cases and their appearance strongly resemble glanders, but of the three tests I made, not one reacted.

(These tests are of importance in so far as they go to show the close resemblance which may exist between glanders and a noncontagious form of chronic nasal catarrh, brought on by exposure and insufficient food or other like causes. It is likely that most of the cases of chronic discharge from the nostrils in horses about which we have frequent inquiries here are of the kind here referred to.)

MALLEIN TESTS FOR SUSPECTED GLANDERS IN HORSES.

No. 1. Exposed to horse supposed to have been diseased. Had nasal discharge, enlarged submaxillary glands and difficult breathing.

No. 2. Mule, 3 years old, was exposed to No. 1 which was suspected; exhibited same symptoms as No. 1.

No. 3. No history of contagion; has had nasal discharge for three years.

	Temperature on day before injection.			Am't Mal'n. used, date & time.	Temperature on day of injection.			Temperature on day after injection.		
	Date.	Time of day.	Temp.		Date	Time of day.	Temp.	Date	Time of day.	Temp.
No. 1.	Sept. 23.	4 p. m.	101	1 c. c. Sept. 24. 6:30 a. m.	24th.	6:30 a. m.	100.5	25th.	10 a. m.	100.5
	"	6 p. m.	100.8		"	8 "	100.5	"	2 p. m.	101
	"	8 p. m.	100		"	10 "	100			
					"	12 "	100.5			
					"	2 p. m.	101			
					"	4 "	101			
					"	6 "	101.5			
					"	8 "	101.5			
No. *2.	Sept. 23.	4 p. m.	102	1 c. c. Sept. 24. 6.30 a. m.	24th.	6:30 a. m.	100.5	25th.	10 a. m.	101
	"	6 p. m.	101		"	8 "	101	"	2 p. m.	101.5
		8 p. m.	100.5		"	10 "	100.5			
					"	12 "	100.8			
						2 p. m.	102			
						4 "	102			
						6 "	103			
						8 "	103			
No. 3.	Sept. 28.	5 p. m.	100.4	1 c. c. Sep. 28 10 p. m	28th.	10 p. m.	100.2	29th.	6 a. m.	100.5
		7 p. m.	100					"	8 "	100.4
								"	10 "	100.4

*No. 2, shows a slight febrile temperature; this is accounted for by her wildness and excitability on taking temperature. Furthermore, the animal from which she was supposed to have contracted glanders (No. 1) exhibited no reaction when tested for that disease.

The following additional tests of the influence of mallein upon the temperature of healthy horses were made in the winter of 1894. The mode of tabulation, in which the temperature at the same hours on the day of injection of the reagent and on the previous day are compared, allows of a more accurate estimate of the effect produced, by diminishing the chances of error due to the normal diurnal variation of temperature. The highest temperature reached after injection of mallein is thus compared with the temperature of the corresponding hour on the previous day. The difference between the estimates of the degree of reaction obtained in this way, and those which are obtained by comparing the temperature at the time of injection with the highest temperature afterwards resulting (the method in which these tables are usually written), is best shown in Nos. 1 and 4. The diurnal variations of temperature in animals are irregular and dependent on many circumstances of environment, but the method here given, the animals being kept in as nearly as possible the same conditions, affords the least chances for error either of over or under estimation of the reaction. This is a matter of importance where the result of the test has to be chiefly decided by the thermal reaction.

All animals in the table below were free from disease of any kind at the time that the test was made, with the exception of No. 1, which was suffering from a chronic nasal discharge. Whether or not this case was one of glanders, was not revealed satisfactorily by the test, but the subsequent history and negative result of inoculation of the nasal discharge to guinea pigs seemed to show that it probably was not. No opportunity was afforded for a second test.

	No. 1.			No. 2.			No. 3.			No. 4.			No. 5.		
	Dec. 2	Dec. 3 1 c. c. at 8 a. m.	Dec. 4	Jan. 29	Jan. 30 1 c. c. at 6 a. m.	Jan. 31	Feb. 1	Feb. 2 1 c. c. at 8 a. m.	Feb. 3	Feb. 3	Feb. 4 1 c. c. at 8 a. m.	Feb 5	Feb. 14.	Feb. 15. 2 c c. at 10 p. m	Feb. 16.
6 a. m.				100	100										99.4
8 "		99.8	99.5	100.3	99.7	100		99			99 3	99.5		99.4	99.4
10 "				100.2	99.5		100.2		100.4	100.2				99.9	100.4
12 "	101	100.5		100.2	100.1										99.9
2 p. m.		102		100.7	100.6		99.6	100.4	100.2	100	100.1	100		99.7	100.3
4 "		103.5		100.4	101			100.2			100.5				
6 "		103		100.1	102.7		100.6	100.6	100 8	101.7	101.5				100.6
8 "	101	103.6		100.1	102.7			100.2			103	102			
10 "		102.8		99.5	102.2		100.1	100.3	100.5	101	102		100.4	100.2	
12 "		101.6		100.2	101.3			100.1			102.5				

No. 1. Swelling at seat of injection reached its maximum size in six hours, 3½ in. diam., slightly elevated and painful. It nearly disappeared in thirty-six hours. Thermal reaction 2.6° F.

No. 2. Local swelling like No. 1. Thermal reaction 2.6° F.

No. 3. Very slight local swelling. Thermal reaction inappreciable.

No. 4. Slight local swelling. Thermal reaction about 2° F.

No. 5. Local swelling moderate. No thermal reaction.

INVESTIGATIONS OF HOG DISEASES.

Clarksville—Clarksville is on the lowlands on the west side of Spadra Creek. This stream is small and does not penetrate into the mountains more than 4 or 5 miles. To the east of Clarksville is Little Pine Creek. This is quite a long stream rising near the north boundary of Johnson County. Near the source of Pine Creek is the source of a much larger one—Big Mulberry. All of these creeks flow into the Arkansas River. To the north and east of Clarksville is a very rough country, and in these mountains the disease first made its appearance. The disease seemed to travel down from the head waters of these creeks and to spread across the country as hogs traveled to wallowing places along the banks. The summer was very dry and the creeks near the headwaters were little more than pools, barely flowing enough to keep the scum off the water. The hogs in the mountains do not come up to be fed, so they wander long distances in search of food. Hogs in town do not wander so far, as they are fed at home and this is the reason why the towns are the last places affected. (Later advice shows that the disease has at last broken out in Clarksville). When I was there (September 1), there was no disease nearer than 6 miles. The further I got into the mountains the more hogs I found to have died. Men hauling apples from Boone County down into the eastern part of the State say that hogs began to die there early in the spring and the disease extended north into Missouri.

The disease is cholera, as my *post mortem* examinations will show:

Autopsy No. 1—Pig, six months old, could not stand; had been sick three weeks. Lungs congested and a considerable quantity of fluid in the pericardial sac, though the heart appeared normal. Stomach full of half-digested acorns and corn; very offensive. Spleen slightly ulcerated, and liver in same condition. Small intestines appeared normal. Ileo-cœcal valve covered by a large, black ulcer. Internal face of cœcum covered with black ulcers. Ulcers extended along the large intestine.

No. 2—Pig, ten months old. Was breathing hard and irregularly. Lungs nearly solid. Heart muscle pale and soft. A quantity of fluid in the pericardial sac. Spleen normal. Liver very much ulcerated. Small intestines filled with lumbricoids. Ulceration at the ileo-cœcal valve. Five large ulcers in the cœcum. A few ulcers in the large intestine.

No. 3—Sow, two years old; very thin and covered with lice. Lungs badly hepatized. Stomach empty. Liver badly ulcerated. Ulcers at ileo-cœcal valve. Serous membrane covered with small, cheesy nodules. Cœcum filled with ulcers, two of which had eaten completely through the walls, large intestines slightly ulcerated.

The history of the outbreak at Clarksville is the same as at all places at which I stopped. Out of about fifteen *post mortem* examinations, only one differed from those above, and that one died with inflammation of the lungs, probably brought on by sleeping in the dust. The surprising thing to me was the freedom from intestinal parasites but this was probably due to the fact that most of the farmers had fed their hogs copperas or soft soap or some favorite prescription for worms and thus cleaned them out.

The only worm I found at all was the lumbricoid, and that was only seen in two cases.

Augusta—The first of August a good many hogs died around town, but it was probably from the dust. There has been nothing like cholera in town. Out about 2 or 3 miles hogs have died with the cholera. The disease was brought in here no doubt by a few male hogs which were brought from Pope County. Up to the time that they were brought in no hogs had died. One man had hogs on both sides of the river and to change pasture with the sick ones he turned them across the river with the result that nearly all on the other side died. *Post mortem* examinations here show all the symptoms as at Clarksville.

Clarendon—I could hear of no hog disease in Monroe County. I found one case of Texas Fever. Several cows died during the summer but not enough to cause any alarm.

Wheatley—I could hear of no hog disease east of here, but people were talking of the disease west in the mountains.

Morrilton—A few hogs died around town early in the summer but evidently not of cholera as no hogs are now sick. Hogs have died in great number throughout the mountainous district. Robertsville has not suffered much, but hogs have died all around there. Near Jerusalem at least 75 per cent have died. Held two *post mortems* at Jerusalem. Both died of cholera. The disease seems, as in all other cases, to come from the mountains on the north.

Altus—No hogs have died in town. At Mill Creek about 50 per cent have died. This is the third year of the disease here. The disease is slow and some hogs recover.

Dover—Disease appeared here about August 1. Six or eight miles above in the mountains hogs have died since early in the spring. Fully one-half of the hogs have died around Dover.

Holly Bend—A few hogs have died at the southeast end of the Bend ever since the deep snow in January. I doubt if this is cholera as I could not find any sick ones. The disease seems to break out in certain localities and does not spread at all rapidly.

Mulberry—A good many hogs have died north of here. The disease has not yet reached the town, though it is within 2 miles of it. It has been in the hills since the 1st of July.

OBJECT OF THE EXPERIMENT.

1. To determine the adaptability of different crops in a rotation for hogs.

2. The cost of rearing ten month pigs on foods gathered by themselves, and grown on soil of known fertility.

3. To ascertain a system of rearing pigs for pork with a minimum quantity of corn.

The production of pork in Arkansas is insufficient to supply the farms, and the number of hogs shipped from the State to market is very small. This condition does not exist to the same extent in northwest Arkansas as it does in the cotton belt, but taking the State as a whole it is sufficient to lead strangers to believe that the State is unsuited to growing pork. Such a conclusion, however, is far from the truth. The winters are mild, a great variety of food products can be cheaply grown, and the health of the hog when properly cared for is as good as it is in any State. Arkansas is so well suited to the production of pork that rearing pigs can be made very profitable. The cotton farmer has heretofore grown an insufficiency of corn to make his pork, and he has believed that corn was essential for rearing and fattening pigs. It has occurred to but few that other and cheaper and perhaps better food could be grown for that purpose. It was mainly to ascertain some information on this subject that the experiment detailed in this bulletin was made.

In rearing pigs for market it is necessary to have a better breed than the scrub, and to give more food and attention than is given to the scrub. There is no necessity to discuss the advantages that would accrue to farmers of the State if they would produce sufficient pork and other foods to supply their own needs, because it must be evident to all that the more money they can keep at home and the more they can bring to the State by shipping agricultural products to other sections the more prosperous they will be as a whole.

The experiment was made at Newport on the sub-station, but the results are applicable to the entire State when the dates are slightly changed to suit the seasons in different localities.

A grade Poland China sow that had farrowed three litters of pigs was bred to a thoroughbred Berkshire boar, and on March 3 she farrowed five pigs—three sows and two boars. All five of these pigs were used together in the experiment, and a record was kept of all food consumed by the sow while she remained with the pigs.

THE FOOD GROWN FOR THE EXPERIMENT.

The soil was a worn, sandy loam, deficient in vegetable matter and would produce about 25 bushels of corn to the acre in a good season. All foods except the corn were gathered by the pigs from small areas confined by movable fence. As often as the crops were closely grazed off the pigs were moved to a new area. Small confined areas were used so as to determine the total area used of each crop. Close grazing of each area acted to some extent against the pigs attaining greater weight.

RYE.

Rye was sown in the fall to be grazed in the spring by the sow and pigs. On March 23, the sow and pigs were turned on the rye and at that date it was 6 inches high. The sow refused to eat but very little, and therefore was kept on it only one week. Her grain feed was slightly reduced as an inducement to eat rye but the effort was unsuccessful.

RED CLOVER.

The clover was in its second year after planting. It was 4 inches high March 30, and the sow and pigs were then taken from the rye and put on it, where they remained until July 26. The spring drouth shortened the clover's growth. Its greatest height where not grazed was 18 inches. The pigs grazed the clover twice.

SORGHUM.

Early Amber sorghum was planted April 19, ten days later, perhaps, than it could have been safely planted. July 26 the sorghum was headed out and in bloom. August 10 the sorghum seed had reached the milk stage and the pigs showed a preference for the heads by eating them first. August 15 the hard parts of the stalk were being refused by the pigs though they were continued on the sorghum till September 21, a period of fifty-four days. They were then put on peanuts and sweet potatoes which were ready two weeks or more before this date.

SWEET POTATOES.

September 21 two pigs were confined on sweet potatoes, and during a period of twelve days they did not take readily to this food, and did not look so well nor gain in flesh as did the three pigs on peanuts. In view of this the sweet potatoes were abandoned and the two pigs were put on peanuts and they at once began a rapid improvement.

SPANISH PEANUTS.

These were planted April 19, without fertilizers. September 21 three pigs were put on the peanuts and the other two were put with them after being on the sweet potatoes for twelve days. During October and to November 15, the weather was very dry and dusty, making feeding on peanuts rather unpleasant. The pigs grew very rapidly, however, while on the nuts. They remained on them till the first freeze which occurred December 2.

CORN.

December 2 the pigs were taken off the peanuts to avoid frequent freezes which would have prevented them from getting nuts regularly as was required by the experiment. They were at this date put on shelled corn soaked in water and given all they would eat. Corn was fed until January 3 at which date the pigs were slaughtered. It was intended that corn should be used only about two weeks to harden the hogs off from peanuts for slaughtering and this could be carried out in farm practice as the pigs could remain on peanuts longer than in the experiment and corn given them when the ground was frozen.

ALFALFA.

The growth of a small area of alfalfa that was in its third year was observed to see how it would supplant clover for early spring and summer grazing. As alfalfa is well known to be relished by hogs and to be an excellent food a feed trial of it was thought to be unnecessary. The notes on alfalfa are reported subsequently.

OATS.

Oats were sown in the fall to be grazed by the sow and pigs in the spring and to compare their value with rye, but the rye was the largest and as clover was ready for use as early as the rye the oats were not used; and moreover oats in east and south Arkansas cannot be relied on to make grain on thin soil because they are subject to rust.

COWPEAS.

The cowpea is a most excellent food for hogs and when planted early would be ready for use by the 1st of July, but early planted cowpeas cannot be relied on for grain and more land would be required than for sorghum. For late feeding for pigs cowpeas can be sown in corn to great advantage. After gathering the corn the pigs can be turned in to gather the peas. The vines would aid in counteracting the effects of the corn crop on the soil. The black pea is the best pea for this purpose as it does not rot while exposed to the weather.

DATA OF THE EXPERIMENT.

The feeding part of the experiment can be better reported by giving the facts and observations as they were made during the progress of the feeding. The feeding period began when the pigs were farrowed and continued ten months, from the 3d of March to the 3d of January.

March 3. The sow farrowed five pigs and beginning on that date she was fed daily in warm kitchen wash water 1 gallon corn meal, 1 gallon wheat bran.

March 17. Increased daily food to 1½ gallons meal, 1½ gallons bran.

March 23. The sow and pigs were put on rye which was 6 inches high. Fed of grain daily 1 gallon corn, ½ gallon wheat bran. The sow's grain food was reduced when put on rye but she refused to eat rye except sparingly so she was taken off after seven days and put on clover.

March 30. Changed sow and pigs from rye to clover. Fed grain to sow separately from the pigs. Fed sow daily 1 gallon corn, fed pigs daily ½ gallon moistened wheat bran. Clover 4 inches high.

April 24. Changed pigs' feed from ½ gallon bran to ½ gallon corn.

May 13. As the sow was showing a disposition to wean pigs she was taken away from them and out of the experiment. Her condition was good though not quite so fat as when the pigs were born. The pigs are seventy-one days old. No increase of grain was given them. Clover in bloom.

June 1. Reduced pigs' feed to 1 quart corn. They apparently suffered none from weaning.

June 10. Pigs were returned to the first area of clover that they had grazed off. Clover is needing rain.

June 29. The clover is tough and only the leaves are being eaten so the grain food is increased to ½ gallon of corn.

July 13. The sorghum has not yet headed out but a few stalks have been given the pigs to accustom them to it before feeding it exclusively.

July 23. The clover is so dried up that the pigs have made no gain for the past ten days and are eating only sparingly the few stalks of sorghum thrown to them.

July 26. Took the pigs off the clover and are giving them sorghum in the pens. They ate fifteen stalks to-day. The sorghum is headed out and in bloom but is not very sweet.

July 29. The entire stalk is readily eaten. Discontinued the grain food to-day.

August 10. The pigs doing well on the sorghum, but the seed, now in milk, is preferred to the stalk.

August 15. The lower part of the sorghum stalks are hard, and are being refused. The pigs are growing but not laying on much fat. They were continued on sorghum till September 21.

September 21. Put three pigs on peanuts. Their total weight was 347 pounds. Put two pigs on sweet potatoes. Their total weight, 218 pounds. The combined weight of the five pigs was 565 pounds. Average individual weight 113 pounds. Age, 6 months and 18 days. The peanuts were ready for use several days earlier, but the pigs were kept on sorghum as it was the cheaper food.

October 3. The two pigs on sweet potatoes are not doing as well as those on peanuts, though the potatoes are in abundance and easy to get. Put these two on peanuts with the others as the sweet potatoes were clearly unequal to the peanuts. As soon as changed to the peanuts they began a rapid growth.

November 15. The ground has been hard and dusty since October 3, and the pigs did not make as good progress as they did after rains fell November 15.

December 2. On account of a freeze up of the ground, the pigs could not get at the peanuts, and to avoid other freezes that would interfere with the experiment, the pigs were taken off the peanuts and put on corn feed exclusively.

Their combined weight was 1,036 pounds.

Gain in 72 days	471	"
Average daily gain	1.31	pounds.

The corn was fed to them shelled and soaked in water, and all that they would eat. This corn feed was continued till January 3, at which date the pigs were slaughtered.

January 3. The pigs were 10 months old to-day, and the experiment was concluded and the pigs slaughtered. Their combined weights are as follows:

Gross (last feed given previous evening)	1,215	pounds.
Net weight same day	1,032	"

AVERAGE INDIVIDUAL WEIGHT.

Gross	243	pounds.
Net	206.4	"

Gain of pigs in 31 days on 19 bushels of corn	179	pounds.
Average daily gain for 31 days	1.15	"
Average gain in pounds per bushel of corn	9.4	"

The last three weights were with stomachs empty.

AMOUNTS AND COST OF GRAIN FED SOW WHILE SHE REMAINED WITH PIGS.

Wheat bran, 66.8 pounds at 65 cents per 100 pounds	$ .44
Corn meal and corn, 9¼ bushels at 30 cents per bushels	2.77
	$3.21

AMOUNT OF GRAIN FED THE PIGS.

Wheat bran, 31.2 pounds	$ .20
Corn, shelled (before 6 months old), 5 bushels	1.50
Corn, shelled (to harden off), 19 bushels	5.70
	$7.40
Total	$10.61

AREA OF GREEN CROPS GATHERED BY PIGS.

Clover, sow and pigs	¼	acre.
Sorghum	¼	"
Peanuts	3/5	"
	1 1/10	acres.

Rye was not grazed enough in the seven days to be estimated. The clover suffered from drouth. Its greatest height was about 18 inches. The sweet potatoes eaten by the two pigs are not estimated because the pigs made no appreciable growth while on them.

Total value of grain foods fed sow and pigs	$10.61	
Total cost of green crops	4.50	
Rent of land, 1 1/10 acres	3.00	
		$18.11
Value of 5 pigs, gross weight 1,215 pounds at $3.25	$39.48	
Profit from rearing 5 10 months old pigs		$21.37
Profit, average per pig	4.27	
Cost of pork per pound	.015	
Market value of pork per pound	.0325	

The cost to keep the sow two months and eleven days over what she consumed to furnish milk for the pigs, is included in the cost of food for the pigs. The reader can increase or decrease these values to suit his surroundings, but they are sufficiently high for all localities in the State, and the rent of land is above the average. No labor is charged for tending the five pigs because it was too small to be estimated; neither is credit made for the peanut hay. The cost to keep the sow six months longer until the next litter of pigs, and the cost to keep the boar that much longer apportioned among several sows, and the interest on the sow and boar, would perhaps bring cost of pigs to about 1¾ cents per pound.

REVIEW OF THE EXPERIMENT.

A practical conclusion of the three objects of the experiment appears to be attained.

1. Red clover, sorghum and peanuts were the best adapted foods for rotation. They are cheap and easy to produce, and their seasons of maturity are in convenient order for pigs to consume them. Rooting for the peanuts was too slight to injure the soil. There is no necessity for root crops for feeding with these foods. Sweet potatoes were unequal to the peanuts in palatability and fat and flesh formers. By this system of rearing and fattening pigs the manure remains scattered over the soil from which the foods were eaten that produced it. This together with the fact that clover and peanuts are soil improvers is a great advantage. Alfalfa and crimson clover are discussed under "Green Crops used in the Experiment."

2. The cost to produce a pound of pork with a pig from birth to 10 months of age on red clover, sorghum and peanuts, and 6⅗ bushels of corn and grown on soil that would produce 25 bushels of corn per acre was 1½ cents.

3. The rotation of red clover, sorghum and peanuts is a system that required 6⅗ bushels of corn to produce a hog weighing 243 pounds at 10 months old. Less corn could have been fed in farm practice by keeping the pigs two weeks longer on peanuts in December, and feeding corn only while the ground was frozen. Two weeks' feeding on corn would have been sufficient to harden the pigs for slaughter.

REMARKS ON THE EXPERIMENT.

The gain on corn was a little less than on peanuts though the corn was fed less than half the time the peanuts were fed. The increase while feeding on corn exclusively is not quite up to the usual gains made while feeding on that food. There is no room for doubt that cooked meal would have been better for this short period. The weight of the pigs September 21, at the age of 6 months and 18 days, is less than it would be in farm practice, because they had an insufficiency of food when the clover was drying up between July 5 and July 29. With crimson clover for winter grazing the brood sow can be kept on green food throughout the year with but very little grain. The pigs were required to graze the clover close, and to eat sorghum clean so that an estimate could be made of the area used of each crop. This requirement for the clover was unfavorable to rapid gains, in fact it was unfavorable to them to some extent on each crop. Sorghum could have been planted ten days earlier, and that would have relieved the pigs from clover that much sooner. This would have caused them to gain more during that time. The peanuts were ready for the pigs August 15, within about fifteen days after beginning the feeding of sorghum, but they were not put on peanuts until thirty-six days thereafter for reasons before stated.

On better soil than that used in the experiment less area would have been used of each crop, and if lime had been applied to peanuts their yield would have been greatly increased. The fertility of the soil should be remembered when considering the cost to rear the pigs, and the area of soil required to produce the food. The pigs were in perfect health on each crop, thus showing those crops to be entirely suited to hogs. Grain was fed the pigs until they were 5 months old with the green food to keep them in health and in rapid growth. A pig will return better profit for food consumed prior to 10 months old than it will after that age is passed.

These pigs were bred to come in March so as to be ready to slaughter in January when the weather is cold enough to preserve the meat without ice and at a season when all parts of the hog can be utilized on the farm. And if the farmer wants to produce pork to cure and sell he will then have the time and suitable cold for doing it. The pigs passed through the summer without any disease though neighboring hogs died in the fall to a considerable extent. Precautions, however, were taken with the experiment pigs to prevent this.

Mineral food was kept in boxes before the pigs throughout their lives. The object was to give them material to build up their bone structure and also to prevent disease. It is necessary to give mineral substance to young pigs for the best success. These pigs ate abundantly of it, frequently to the extent of coloring their droppings.

The mixture was:

Charcoal	1½ bushels.
Common salt	4 pounds.
Hard wood ashes	10 “
Slacked lime	4 “

The charcoal was broken into small pieces and the other substances mixed with it. One pound of superphospate of lime would be better than the common lime or this might be replaced by an equal amount of burned bones. Such a mixture as this should be kept accessible to hogs at all times and in a place protected from rain. These pigs were frequently noticed to stop grazing or eating corn and go to the box and eat heartily of the mixture. It destroys all intestinal worms in hogs and otherwise maintains their condition.

The pigs showed no disposition to root while on the clover and when put on Spanish peanuts very little rooting was required to get the nuts, not enough to injure the soil in any way. This variety grows its nuts clustered closely around its center and near the surface.

THE GREEN FOODS USED IN THE EXPERIMENT.

The green foods: Clover, sorghum and peanuts used in the experiment succeed each other in coming into use very satisfactorily, but the second crop of clover becomes rather dry and hard from June 25 to July 15, making a period of twenty days of indifferent green food. In this period of twenty days the clover could be advantageously assisted by an early variety of cowpea.

During early spring and summer our alfalfa was closely watched to determine its adaptability to take the place of clover, and part of the sorghum before the latter has fully reached its feeding stage, and the result is that I believe it to be entirely suitable for the purpose. Its growth would not diminish like the red clover does between June 25 and July 15. During that period alfalfa was green and succulent, and did not suffer for rain in the spring as did the clover. The alfalfa was mowed four times, height of first three mowings, 2 feet; height of last mowing, 18 inches. It was ready for grazing about ten days earlier than red clover, and it is permanent while red clover has to be sown about every two years. Its yield is much larger per acre, and therefore will graze more pigs, and they are just as fond of it as they are of red clover. The alfalfa grew on soil adjoining the red clover, and it was of the same quality, so the comparison of their relative merits was an easy matter. The use of alfalfa instead of clover would materially reduce the cost of pork. If farmers have pigs farrowed earlier or later than March, crimson clover should be planted in early fall to make fall and winter grazing for the pigs, then to be followed by alfalfa, sorghum and peanuts or red clover, sorghum and peanuts for successive crops. If it is undesirable to have hogs rooting peanuts in December when freezes occur, the black cowpea can be had ready in corn fields for the pigs to go on. These peas will remain all winter without rotting, and the vines and roots will restore the wear on the soil by the corn crop. The vine of the Spanish peanut grows upright, and can be easily cut with the mower for hay. The quality of the hay is most excellent, and is sufficient in quantity to very nearly pay the cost of cultivating the peanut crop.

Oats and rye cannot be economically used in a rotation when crimson clover, red clover and alfalfa are available. These legumes improve the soil as well as the pigs while the rye and oats exhaust it, and they also require better soil than the legumes.

Sweet potatoes are rather expensive to grow, and sugar beets would far out yield them but require better soil.

REMARKS ON REARING PIGS.

As this experiment shows that pork can be produced very profitably and the soil improved at the same time by a rotation of crops, it is perhaps not out of place to briefly suggest a few points that are necessary to be observed in rearing pigs if success is to be attained.

1st. The hog must be an improved breed, and not scrub. The best pig is a three-quarter thoroughbred and one-quarter good scrub. The sow should be a large bodied pig of a large thoroughbred black breed, and the scrub part should be from the best of its kind. She should then be bred to a thoroughbred boar of a breed smaller and finer boned than herself. This will give pigs with the hardy habits of the scrub, eating capacity of the large breed and the refined bone and flesh-forming qualities of the refined thoroughbred boar. An Essex boar or a Berkshire boar of the smaller strains are best, and a half Poland-China sow will make the desired combination.

2d. The sow and boar must be properly fed and cared for, especially the sow at pigging time and afterwards. One service of the sow by the boar is sufficient.

3d. The pigs must be pushed in the first six months of their lives. This is done by feeding grain and succulent green foods. While quite young, milk, with shorts or meal in it, makes the best food for pigs.

4th. Pigs must have good pasture and grain. But few farmers recognize either of these essential. To confine pigs in a small pen for six months and feed them on corn, without green food, is wasteful. If the hogs are given grain and green food together, they will increase 20 to 40 per cent more than if no green food is given them. Green food is more essential in the summer than in the winter. The pig is as much a grass as it is a grain eating animal. To confine pigs in filthy pens for any length of time, and force them to eat in their own droppings, as is very frequently done, is very injurious to the pig. The pig is a cleanly animal in its habits and will not live in its own filth if permitted to do otherwise. Neither will they scatter their droppings all over their pen, but will have a special place for it and the urine.

5th. Pigs should be kept away from foul water and wallowing holes. The reader is referred to Bulletin 35 for sanitary precautions to be observed in rearing hogs. Dr. Dinwiddie is making a special study of hog diseases in the State, and has just issued a preliminary bulletin on the subject. Extremely large, fat hogs are no longer more desirable for pork than smaller pigs with less "blubber" fat. A pig with a "streak of lean and a streak of fat" makes the sweetest and most palatable pork.

If home-made pork is well trimmed and carefully cured and smoked it will bring better prices in home markets, and if the lard is free of color and firm, it will likewise sell better. By going to a little expense for food crops to supplement the waste that occurs on the farm and from the kitchen, the farmer's supply of pork can be made at an inappreciable expense, while as the case now is on many cotton farms the pork supply is bought and these waste foods are lost.

The performance of the foregoing experiment was in the charge of Mr. G. B. Irby, assistant agriculturist at Newport.

R. L. BENNETT,
Agriculturist.

PRODUCTS OF CERTAIN SMALL MILLS.

With the adoption of roller milling machinery into flour mills the processes of flour manufacture and the products themselves have undergone a radical change from what existed under the old system of mill-stone milling. A more complete separation of the bran from the flour material is made, and the germ or portion of the kernal which produces the sprout, finds its way not into the flour as before, but into the offal. In nearly all mills the flour is divided into two or more qualities and in many mills the offal is divided into two products which are of very different nature and which consequently have different food values.

While among flouring mills, each differs from nearly every other in details of construction and arrangement; they are all essentially the same in that the bran is separated from the interior of the grain, and this interior is reduced to flour by repeated crushing between rollers followed and intermingled with numerous separations by suitably arranged bolting machines of various kinds. The details of this process must be left to the miller. The farmer has to do only with the material which he takes to the mill and the products which he takes away or which are sent to him in those sections where wheat is not grown. All of these products in considerable quantities find their way into various parts of this State. They differ in price and have different merits for various purposes.

With the above points in mind and also for the purpose of learning something more definite concerning the chemical nature of different parts of the wheat grain, which are separated with some distinctness in flour milling, a series of investigations has been in progress during the last three or more years. They have given some results and promise more in the future.

Among other things undertaken, three separate test runs of wheat have been made at two different mills. The parts of the mill in use were cleaned as thoroughly as possible of material which it contained from previous work, and a like cleaning was made at the end of each run. The wheat used and the resulting products were accurately weighed. Small samples of each were taken and submitted to the usual methods of food analysis. Complete ash analyses were made of the wheat and products of the third test run. An attempt was also made to separate the products containing nitrogen*(crude protein) into different classes based upon an extensive study of this subject recently made by Dr. Osborne at the Connecticut State Experiment Station. The germ of the wheat has in some instances been collected, carefully separated from all foreign matter and submitted to partial analysis. The first milling trial was made in a long process roller mill (7 breaks) grinding about 40 bushels per hour. The other two trials were made in a four break mill, grinding about seven bushels per hour and using the plansifter method of bolting. Detailed results of these trial runs and results of some of the analyses made are given below.

In all of these trials winter wheat grown in Washington County, Ark., was used. In the first trial was a mixture of several small lots brought in during the day by farmers. In the third trial a uniform lot of Fulcaster wheat of fair quality, slightly affected with weavil, was used. That used in the second trial was a red wheat, variety not known.

WHEAT MILLING TRIAL No. 1.--MADE JANUARY 2, 1894.

Weight uncleaned wheat, 7,000 pounds.

Products.	Weight Pounds.	Per Cent of Uncleaned Wheat.
Patent Flour	848	12.11
Straight Flour	3,964	56.63
Low Grade Flour	250	3.55
Bran	1,636	23.37
Tail of Mill (ship stuff)	174	2.48
	6,872	98.14
Screenings	78	1.1
Loss (dust, etc.)	50	.7.

TABLE SHOWING FOOD CONSTITUENTS IN PRODUCTS OF MILLING TRIAL No. 1.

Figures show pounds of food material in each 100 pounds of product.

	Patent Flour.	Straight Flour.	Low Grade Flour.	Ship Stuff.	Bran.	Whole Wheat.	Pure Germ.
Water	13.75	13 90	13.22	12.25	12.85	13.90	6 80
Ash	.33	.47	.90	3.12	5.80	2.15	4.65
Crude Fiber	.17	.26	.74	3.55	6.14	2.17	1.60
Fat	1.05	1.25	1.70	4.80	5.20	2.15	14 38
Crude Proteids*	9.69	10.37	12.88	16.36	15.56	12.31	36.00
Carbohydrates	75.01	73.75	70.56	59.02	54 45	63.32	36.55
	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Total Nitrogen	1.70	1.82	2.26	2.87	2.73	2.16	6.34
Albuminoid	1.65	1.72	2.20	2.68	2.51	1.98	
Amide Nitrogen	.05	.10	.06	.19	.22	.18	

*Crude proteids in these analyses represent the nitrogen found, multiplied by 5.70, this factor being the result of the average amount of nitrogen found in the proteids of the wheat kernal by Dr. Osborne as given in the report of the Connecticut Agricultural Experiment Station for 1893, pp. 177-179. For wheat grain this factor gives a far more accurate result than does the factor 6.25, which has heretofore been in general use.

WHEAT MILLING TRIAL NO. 2—MADE MARCH 15, 1894.

Weight uncleaned wheat, 3,000 pounds.

Products.	Weight Pounds.	Per Cent of Uncleaned Wheat.
Patent Flour	529.5	17.65
Straight Flour	1,510.5	50.35
Low Grade Flour	69.5	2.32
Shorts	33.0	1.10
Dust Room Contents	24.5	.82
Bran	723 0	24.10
Screenings	81.0	2.70
Sample Cleaned Wheat	1.5	.05
Loss	27.5	.91
	3,000.0	100.00

TABLE SHOWING FOOD CONSTITUENTS IN PRODUCTS OF MILLING TRIAL NO. 2.

Figures show pounds of food material in each 100 pounds of product.

	Patent Flour.	Straight Flour.	Low Grade.	Dust Room.	Ship Stuff.	Bran.	Wheat Cleaned.
Water	14.05	14.04	13.90	13.04	13.50	12.55	13 70
Ash	.26	.35	.78	2.81	1 21	5.85	1.85
Crude Fiber	.17	.22	.54	6.06	.98	6.51	2.03
Fat	.93	1.27	1.80	3 15	2.50	4.80	1.85
Crude Proteids*	8.49	9.80	13.79	12.65	14.82	16.30	11.40
Carbohydrates	76.10	74.32	69.19	62.29	66.99	53.99	69.17
	100.00	100.00	100.00	100.00	100 00	100.00	100.00
Total Nitrogen	1.49	1.72	2.42	2.22	2.60	2.86	2.00

* Crude proteids equal nitrogen multiplied by 5.70. See under Milling Trial No. 1.

WHEAT MILLING TRIAL No. 3.—MADE NOVEMBER 30, 1894.

Weight uncleaned wheat, 3,000 pounds.

Products.	Weight Pounds.	Per Cent of Uncleaned Wheat.
Patent Flour	774	25.80
Straight Flour	1,260	42.00
Low Grade Flour	116	3.87
Dust Room Contents	35	1.17
Ship Stuff	34	1.13
Bran	714	23.80
	2,933	97.77
Screenings	55	1.83
Tailings	10	.33
Loss	2	.07

TABLE SHOWING FOOD CONSTITUENTS IN PRODUCTS OF MILLING TRIAL No. 3.

Figures show pounds of food material in each 100 pounds of products.

	Patent Flour.	Straight Flour.	Low Grade.	Dust Room.	Ship Stuff.	Bran.	Wheat.
Water	14.00	13.98	13.90	13.05	12.50	12.60	13.80
Ash	.31	.40	.70	2 50	3.08	5.25	1.62
Crude Fiber	.18	.26	.47	4.41	3.07	6.51	2.50
Fat	.85	1.00	1.75	3.65	4.75	5.00	1.90
Crude Proteids*	8.78	9.98	12.14	12.37	15.85	15.56	11.17
Carbohydrates	75.88	74.88	71.04	64.02	60.75	55.10	69.11
	100 00	100.00	100.00	100.00	100.00	100.00	100.00
Total Nitrogen	1.54	1.75	2.13	2.17	2.78	2.73	1.96

*Crude Proteids represent the nitrogen multiplied by 5.70 as indicated in note under results of Milling Trial No. 1.

The dust room contents mentioned above consists largely of the outer portion of the bran mixed with a little material which would otherwise have made flour. A sample of this material was sifted to remove the flour particles and the residue, consisting of the material which millers call "bees wings" was analyzed. The results are given below in connection with the analysis of screenings from milling No. 3.

TABLE SHOWING COMPOSITION OF SCREENINGS AND SIFTED DUST.

	Water.	Ash.	Crude Fiber.	Fat.	Crude Proteids.	Carbohydrates.
Sifted Dust	6.25	2.25	19.77	.78	5.13	65.82
Screenings	12.70	2.57	3.55	2.50	12.03	66.65

The analysis shows this wheat screenings to be a valuable article of food for stock and such is the usual case with this offal. A short discussion of the food value of ship stuff and bran is given in Bulletin No. 30 of this station, page 158, and is in accordance with what the above analyses teach. As that bulletin is probably in the hands of most of the readers of this one, the discussion need not be repeated here. In the smaller mills these articles are usually run together and sold simply as bran, but they are kept separate in larger mills, and that which is sold as ship stuff will usually cost about $1.00 per ton more than the bran. The relative composition of these two articles differs in the output of different mills, but in general the ship stuff has an increased food value corresponding in a measure with the increase in price.

CLASSIFICATION OF FLOURS.

Since the details of flour manufacture differ so greatly in different mills it is apparent that the products from all mills will not be of uniform quality. So, too, the wheat used, its condition when milled, the condition of the mill and other things tend to vary the quality of the output from the same mill at different times. These variations are often recognized by purchasers of the flour, and on the other hand, flour is probably often blamed for being poor when the difficulty lies wholly or in part with the user of it, as when it is not adapted to the special details of bread baking habitually practiced by that person.

Nearly all mills sell their flour under special brands or trade names. Often these are registered under government laws and can be used by other millers only at their peril. Each miller will have as many of these trade names as he has qualities of flour. If the flour sold under the same name were always of uniform quality, purchasers might be guided materially by them, but for reasons indicated above, these qualities are not always uniform. There is little doubt, however, that the mill brand furnishes the most reliable guide which purchasers of small quantities of flour have for judging of the quality of the article which they wish to purchase.

There are means at the disposal of large consumers of flour which enable them to judge quite accurately of the quality of the article they are buying. Such means are, comparison of color, capacity to take up water, accurately conducted baking tests which may be readily applied to small quantities of many samples of flour, and other means, the details of which cannot be given here. These methods are resorted to by professional bakers and others, the amounts of whose purchase justify the expenditure of the time and labor and the purchase of the necessary apparatus.

In large market centers, such as St. Louis, Chicago and Philadelphia, the flour which is bought or sold by local dealers is often submitted before the transfer to inspection by authorized flour inspectors. These report upon the average weight and condition of the separate packages and their contents, and the terms of the sale are arranged accordingly.

A quite thoroughly organized inspection is carried on in St. Louis under the direction of the Merchants' Exchange. Here, when inspected, the packages of flour are stamped with the brand of the flour inspector, which mark indicates the date of inspection, the weight of the package, the condition of the contents as to soundness or unsoundness, and may indicate its quality or grade. Quality or grade are indicated by names adopted by the Board of Flour Inspectors in much the same way as trade names are adopted by a mill owner. The names of the grades of the St. Louis Merchants' Exchange Board of Flour Inspectors are: Patent, Extra Fancy, Fancy, Choice, Family. The first named indicates the whitest and highest quality, the last indicates the darkest and lowest grade of flour. The other names indicate intermediate grades corresponding to the positions which the names occupy in the above list.

As a guide for the use of the various deputy flour inspectors the Board of Flour Inspectors prepares a series of standard grades to be used for comparing with the flour which is being inspected. Many of the millers of St. Louis and vicinity also obtain samples of these standards and gauge the qualities which they produce by them. To provide against changes which flour undergoes with age, fresh standards are prepared at intervals of two or three months.

B. W. Kilgore

Market quotations from St. Louis, Memphis and Little Rock state prices for all or part of the above grades of flour and use those terms for designating the different qualities of flour upon the market. Other cities, like Philadelphia, Baltimore and Boston, use different names for their standard grades, and some cities in which inspection is carried on use none whatever.

Flour inspection in the various cities is for the most part under the control of merchants who have organized and established the system for their mutual protection. There is every reason for believing that it is a most effectual means of protecting both buyer and seller. More than a suggestion as to the value of an efficient system of flour inspection, whereby the actual quality of any flour in the market may be known to the consumer, or purchaser of small quantities, cannot be given here. There are reasons for believing that such a system would be of material benefit to all who have anything whatever to do with this article.

COMPOSITION OF FLOURS.

An examination of preceding tables of analyses show that the highest proportion of carbohydrates is found in the whiter flours. In a perfectly ripened, unsprouted wheat these carbohydrates consist almost entirely of starch. The low grade flours contain much less carbohydrates than the patent flours. The analyses also show an increase of fat, ash and fiber in the lower grades of flour. A very marked variation in the amount of crude proteids also occurs. Further examinations, the results of which are not given in the preceding tables, show the different groups of proteids, which together make the total proteids to differ very markedly in their relative proportions in these different grades.

The proteids which are considered of most importance in wheat flours are those which constitute what is known as gluten. Gluten is an elastic semitransparent mass of material which remains when flour is carefully washed with water in such a way as to remove the large quantities of starch and other matters which always occur with it. If a few spoonfuls of flour are mixed with water to a moderately stiff dough and allowed to stand for an hour in a saucer or other convenient dish the threads of gluten may be readily seen by pulling the mass apart with the fingers. If the mass of dough be placed in a strong cotton or linen cloth and worked between the thumb and fingers in a quantity of water until a fresh supply of water does not become milky from separated starch after a few minutes working, nearly pure gluten will remain in the cloth and its nature can then be readily seen.

It is this gluten which gives wheat flour its peculiar value for bread making purposes. The carbonic acid gas which is formed by the growth of yeast in a mass of bread dough, or which is set free from baking powder when it is wet with water, or from baking soda when it is wet with sour milk, accumulates itself in numerous small pockets which it forms in the dough. These pockets are formed because of the presence of this tenacious gluten which is so elastic as to permit the gas to force it aside without breaking it and yet so compact as to prevent the escape of the gas. The walls of the pockets formed retain their places when the bread or cake is baked, giving a light porous loaf very different from that of bread made from corn flour. Corn contains no gluten.

The gluten of different flours differs not only in amount but in quality. Bakers like a flour containing much of a very strong gluten. Such flours will take large quantities of water and make more bread to a given weight of flour. Consumers of baker's bread and those who bake their own flours do not want water from this source. They want bread. However, most all who use light bread wish a light porous loaf, and to obtain this a flour must be used which contains a sufficient amount of a good quality of gluten. They also want a bread which will retain moisture well, which will be light in color and which will be agreeable to the taste. These qualities they cannot get by the use of a very low grade of flour. In many instances they probably cannot get all of them by the use of a very high grade, because such flours are made from the more starchy portion of the grain and are deficient in gluten.

Flour from hard spring wheat contains much gluten of a high quality and is much sought after by some bakers, who use it either alone or to mix with other flours. There does not seem to be reasons for believing that flours from soft winter wheat produced in this section of country are so deficient in gluten as to make them in any way inferior for general use. This is especially true since much of the bread consumed in this State is used in the form of warm biscuit, for the making of which flours from soft wheat are even more suitable than from hard wheat. Lower grades of flour can also be used for the making of warm bread than for the making of the so-called light bread. The most suitable use for human food to which very low grades of flour can be put is to the making of griddle cakes for which purpose they seem even superior to the better qualities of flour.

It is a common opinion of many that the highest priced article of any kind will prove most economical in the long run. This is not necessarily true of wheat flours. High priced flours are preferable to some because of their very white color. The medium grades of flour will contain more gluten and yet do not partake in a very large degree of those objectionable qualities found in a very low grade. Different individuals differ in their tastes and some will prefer the flavor of a lower grade to that of the highest. There is unquestionably a difference in the amount of waste which will occur from breads made of different qualities of flour, and this difference will vary for the same flour according to the tastes of consumers of the bread.

In general the lower grades of flour from the same wheat will contain the highest proportion of gluten. This increase of gluten is, however, less than the increase of crude proteids. There has been a common practice of pronouncing food containing a large proportion of proteids to be superior foods; that is, foods supplying a greater amount of nutriment. In the case at least of different flours from the same wheat there are other matters which come in direct opposition to this. As bearing directly on this point the following extract is quoted from a valuable paper on the chemistry of wheat and flour published by Lawes & Gilbert, of England, in 1857:

> "It is also well known that the poorer classes almost invariably prefer the whiter bread; and among some of them who work the hardest, and who consequently would soonest appreciate a difference in nutritive quality (navvies, for example), it is distinctly stated, that their preference for the whiter bread is founded on the fact, that the browner passes through them too rapidly; consequently, before their systems have extracted from it as much nutritious matter as it ought to yield them."

The authors of this sentence attribute the facts stated to the mechanical action of the hard, branny particles upon the intestines. In those days milling was entirely done by the use of millstones, and a much larger proportion of bran found its way into the flours than occurs with the roller process now in use. An examination of the tables of analyses does not show a large proportion of crude fiber even in the lowest grades of flour and yet there are some reasons for believing that this laxative influence possessed by low grade flours in those days still occurs. The proteids not gluten are much more abundant in the bran than in the flours, and the laxative effect of bran-mash fed to horses and other animals which consume such coarse fodders as hay, can hardly be attributed to the hard, branny particles, because bran contains not more than one-fifth as much crude fiber as the average hay, and that which it does contain is not less easily softened by moistening than that which is contained in the hay. It would seem, therefore, that the laxative effect of bran and low grade flours is due rather to the kind of proteids which they contain than to the mechanical action of their branny particles.

This laxative action of bran and low grade flours may be made to serve a useful purpose as a food for some, and finely ground whole wheat meal, or graham flour, may be especially useful for that purpose and for giving a change of food as well as for supplying a larger proportion of bone forming material, which it contains as ash. Where bread forms a very large proportion of the food this special value of the ash constituents, especially for growing children, may be great. Where considerable quantities of other foods, such as vegetables, milk and meat, are consumed, the bone material will be supplied in sufficient quantities even when the very whitest qualities of flour are used. Among other foods, peas, beans and oatmeal are especially rich in bone forming material.

THE FERTILIZER ELEMENTS CONTAINED IN WHEAT.

The ash of wheat is made up chiefly of the phosphates of potash, magnesia and lime. The results of a complete series of analyses of the ash of the products obtained in the third milling trial is given in Part 2 of this Bulletin, and the percentage of all the ash ingredients of each ash is there shown. For the purpose of illustrating here some important points, the absolute weight, in pounds, of the phosphoric acid, potash, magnesia and lime computed for the entire weight obtained of each of the mill products, and of a corresponding amount of the cleaned wheat, are given in the table below. The weight of total nitrogen occurring in each is also given.

TABLE SHOWING WEIGHT OF CHIEF ASH CONSTITUENTS OF WHEAT AND ITS PRODUCTS.

	Patent Flour. lbs.	Straight Flour. lbs.	Low Grade. lbs.	Dust Room. lbs.	Ship Stuff. lbs.	Bran. lbs.	Wheat. lbs.
Substance	774.	1260.	116.	35.	34.	714.	2933.
Total Ash	2.399	5.040	.812	.875	1.044	37.342	47.514
Phosphoric Acid	1.153	2.486	.431	.437	.570	19.720	24 715
Potash	.924	1.830	.262	.270	.293	10.527	14.112
Magnesia	.105	.322	.076	.113	.138	5.512	6.286
Lime	.139	.287	.037	.031	.029	.933	1.473
Nitrogen	11.92	22.05	2.47	.76	.945	19.50	57.48

It will be seen from the above that of the valuable fertilizing elements which occur in wheat there are found in those mill products which are used for stock food, about seven-eighths of the entire phosphoric acid, eleven-fourteenths of the potash and three-eighths of the total, nitrogon. The total value of these three fertilizing elements, based upon prices at which they can be obtained in market centers of this State, is $7.50 for the 50 bushels of wheat. Almost one-half of this value of fertilizing elements is found in the bran and other offal. As has been pointed out in previous bulletins of this division of the Experiment Station, little of these fertilizing elements are retained by the animal to which the food is fed. If the bran be recovered from the mill to which the wheat is taken, fed to stock and the resulting manure carefully saved, nearly one-half of the soil fertility which would otherwise be lost in the selling of the wheat will be preserved and the live-stock will have the benefit of a most excellent concentrated food. Readers are here reminded, however, that this is only one argument concerning a method of practice, a discussion of which does not come under the scope of this publication.

It may be further pointed out in this connection that Lawes and Gilbert in England, have found as partial results of an extensive experiment on wheat, grown under different methods of manuring and for many years in succession on the same soil, that the average amount of straw which will produce 50 bushels of wheat is about 5,000 pounds. They found further that this straw will contain an average of 7.6 pounds of phosphoric acid, 21.5 pounds of nitrogen, and 44.8 pounds of potash. These, valued at the same prices as in the preceding paragraph, would show the fertilizing elements in the straw to be worth $4.53, or about three-fifths of the value of the fertilizing elements in the 50 bushels of wheat which the straw would produce. The straw itself contains fertilizing elements greater in value than are those contained in the flour of the wheat.

One of the greatest needs of many of the soils of this State is more vegetable matter, and straw applied to the soil has a value beyond that due to the presence of the most important fertilizing elements which it contains. In those sections where wheat is produced the straw should be preserved and made to assist in maintaining the fertility of the soil.

The finding of zinc in the ash of this wheat may be mentioned as a point of special interest. The amount found would equal about 1 pound of pure zinc to each 500 bushels of wheat. So far as it has been possible to learn, this small amount of zinc has no special influence upon the growth of the plant nor is it in any way injurious to animals or human beings eating the grain. It is found most abundantly in the ash of the outer portions of the grain and is present in the flour ash in much less quantities than in the ash of the bran. In the ripened wheat it seems to have been transferred almost completely from the straw to the grain. Zinc was also found in oats, clover hay and corn cut before tasseling. All of these were produced upon soil in the vicinity of that producing the wheat which was used in the milling trial. An examination of the first 6 inches of this soil showed it to contain about 1 pound of zinc to each 1,000 pounds of earth. Zinc has been previously found in the ash of many plants and of some animals in Europe. Its presence in considerable quantities in drinking water has produced no noticeable injury to those using it for many years.

LOSS DURING THE SPROUTING OF WHEAT.

While everybody recognizes that wheat is injured by sprouting, as when in shock, the amount of loss which occurs is not generally understood. In an experiment for a purpose pointed out in Part 2 of this Bulletin, equal weights of the same wheat were sprouted, under uniform and most favorable conditions, for different lengths of time varying by intervals of twenty-four hours each. Each sample at the close of its sprouting period was carefully air dried and later the absolute amounts of dry matter in each and in the original wheat were determined. This was necessary to give a uniform basis of computation, as otherwise accidental variations in the amount of moisture may have given misleading results. In the following table is given the amount of wheat which would remain from 100 bushels of the original wheat after it had sprouted for the number of hours shown in the first column of the table and had then been dried till it contained the same amount of moisture which was present before it was wetted for the sprouting. The number of bushels lost from each 100 bushels of the original wheat is also indicated.

TABLE SHOWING LOSS OF WEIGHT UNDERGONE BY WHEAT SPROUTING FOR DIFFERENT LENGTHS OF TIME.

Time Sprouted.	Parts Remaining of Each 100 Parts.	Parts Lost of Each 100 Parts.
24 hours	98 5	1.5
48 hours	97.5	2.5
72 hours	94.1	5.9
99 hours	93.3	6.7
120 hours	89.9	10.1
144 hours	88.2	11.8

At the end of the sixth sprouting period two of the more advanced grains were beginning to burst their first leaf and a large number of other grains were not far behind in the sprouting stage. The most advanced kernals were, however, not beyond the stage where wheat shocks begin to turn green from the sprouting grain. It was endeavored to carry on this experiment under such conditions that the entire amount of wheat was given the best possible conditions for its sprouting. It is probable that the sprouting of the entire mass of wheat in shock does not generally occur, but it is apparent from the foregoing results that there is a decided loss in the weight of the harvest when wheat is allowed to sprout for a very short time only, and the amount of loss for a given length of time will be dependent upon the amount of wheat affected.

Aside from the loss in weight which occurs in the sprouting of wheat, marked chemical changes are brought about which decrease greatly the value of the article for bread baking purposes, and probably also as a food for stock.

The importance of protecting the wheat by proper stacking or storing in barns as soon as possible after it is ripe and dry is great. The expense of stacking will often be small as compared with losses which may occur by attempting to wait till a machine can be procured for the purpose of threshing direct from the shock.

It is possible that the lack of profit to the farmer is often brought about through the many small losses of this character which might be prevented. Successful manufacturers, merchants and others make it a point to look after the apparently unimportant details of their business with the greatest of care and to insure against loss, whether by fire, wind or rain, is almost universally acknowledged to be a sound business principle.

G. L. Teller,
Station Chemist.

Part 2 of this Bulletin contains a record of certain investigations concerning wheat and its mill products, the results of which have either been briefly stated for the use of the farmer in Part 1, or are not yet sufficiently developed to be adapted to their needs. These investigations are, however, of more or less importance to experiment station workers and others engaged in scientific studies, and that they may be accessible to such they are grouped together and published in a limited edition of a few hundred copies only. Parties desiring a copy of the same may obtain it by writing for Bulletin No. 42, Part 2.

Part 2 of this Bulletin treats of the following subjects:

A Complete Ash Analysis of Wheat and its Mill Products.

Alumina a Constituent of the Ash of Certain Wheat.

Zinc a Constituent of the Ash of Some Arkansas Farm Plants.

Studies Concerning the Proteids of Wheat and a Method for their Quantitative Separation.

COMPOSITION OF THE ASH OF A WHEAT AND ITS MILL PRODUCTS.

The following series* of ash analyses was made for the purpose of obtaining some further information concerning the distribution of various ash ingredients in the wheat grain and in the different products of modern flouring mills. The samples examined are those of the milling trial No. 3, of which detailed results are given in Part 1 of this bulletin. The figures given in the table indicate in per cent of total ash, the amount of each constituent named.

	Patent Flour.	Straight Flour.	Low Grade.	Dust Room.	Ship Stuff.	Bran.	Wheat.
Silica	2.33	1.28	.50	1.34	.49	.97	1.04
Alumina	.41	.15	.12	.04	.18	.07	.11
Ferric oxid	.47	.26	.25	.30	.37	.27	.27
Potash	38.50	36.31	32.27	30.85	28.03	28.19	29.70
Soda	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lime	5.59	5.65	4.51	3.53	2.80	2.50	3.10
Magnesia	4.39	6.44	9.33	12.90	13.27	14.76	13.23
Phosphoric acid	48.05	49.32	53.10	49.94	54.62	52.81	52.14
Sulphur trioxid	.16	.52	.00	.58	.00	.10	.22
Chlorin	....	....	....	....	....	.01	.01
Zinc oxid	....	.04	....	.46	.36	.27	.24
Sum	99.90	99.97	100.08	99.94	100.12	99.95	100.06
Per cent total ash in each	.31	.40	.70	2.50	3.08	5.25	1.62

The ashes for these analyses were prepared in a Fletcher's muffle furnace No. 5, heated by an ordinary Fletcher's gas cooking burner. The

---

*The results of a somewhat similar series of ash analyses by Dempwolf are given in *Annalen der Chemie und Pharmacie,* Bd. 149, pp. 343, 350. 1869.

platinum dishes in which the material was burned are capable of holding about fifty grams of the pulverized material each. The muffle is just large enough for two of these dishes. As the material in the dishes decreased sufficiently in bulk 25 grams of fresh material was added and this was continued till enough had been taken to produce a sufficient amount of ash. The burning was then continued till the ash was of a very light gray color. Care was taken in each instance that the temperature of the muffle in its hottest place should not rise above a gentle redness. The dishes were protected from the bottom of the muffle by a thick sheet of asbestos cloth. The ash thus produced did not fuse and was perfectly loose and free. The small amount of unburned carbon was determined and deducted from the crude ash to give the pure ash upon which all computations are based. No carbonic acid was found. The analyses of ash were all made by me personally with as much care as could be commanded.

It has been suggested that the absence of sodium and chlorine in these ashes may be due to their having been volatilized during the burning. This error is possible. However, it could not well be prevented. Attempts were made to extract the charred mass with dilute acetic acid as soon as all volatile matter was driven off but the char was a porous, very hard mass, which could be pulverized only with great difficulty and which could not be well extracted otherwise, so that the probabilities of error by this method seemed much greater than by direct burning. The method is, too, essentially that used by Lawes & Gilbert in the preparing of the considerable number of wheat ashes which they have had analyzed, except that they were not required to add the unburned material in parts.

Among the variations in composition in the ash from different parts of the wheat grain the most noticeable are the very marked increase in the proportion of potash and lime toward the interior of the grain and the still greater decrease in the proportion of magnesia in the same direction, that is, from the bran to the whitest flour. The presence of zinc will be discussed later. It was present only in very minute quantities in the ash of the flour. The amounts could not be determined in the patent and low grade flours for the want of more material.

The variation in the amount of sulphuric anhydrid present was to be expected. It indicates nothing special. Any sulphates present may easily have been reduced and the sulphur volatilized in the burning of the ash. Sulphur is always present as one of the essential elements of the proteids, and would, under suitable conditions, have been converted into sulphates during the burning. The presence or absence of sulphur in the ash is probably largely dependent upon the relative proportion of the strong bases and the phosphoric acid in the material burned. A determination of the total sulphur in each material was made by fusing 2 grams of the substance with a sufficient amount of nitrate of potash and potassium hydrate in which the absence of sulphur in weighable quantities had been verified.

PER CENT OF SULPHUR IN WHEAT AND ITS MILL PRODUCTS.

Patent Flour.	Straight Flour.	Low Grade Flour.	Dust Room Contents.	Ship Stuff.	Bran.	Wheat.
.09	.10	.16	.15	.17	.21	.13

ALUMINA IN THE ASH OF WHEAT.

The finding of alumina in the ash of plants has been often mentioned but it has been attributed to possible clay or dust adhering to the surface of the material from which the ash was obtained. Wanklyn* and Cooper report alumina to be a usual constituent of wheat flours. They attribute the presence of a part of it to the wearing down of the millstones. This could not have been a source of the material in these mill products, as the wheat was crushed entirely by iron rollers and an examination of the amounts of alumina found in the mill products and in the whole grain indicate that it is no more foreign to the true ash than any of the other constituents named. To bring further proof on this point, 100 grams of the unground wheat was carefully washed with distilled water, and after drying, was burned without being pulverized. The same amounts of both alumina and zinc were found as in the wheat which had not been washed. It seems a little remarkable that the zinc should have accumulated to the greatest extent in the ash of the bran while the alumina and silica should have reached their largest proportion in the ash of the finer flours. Alumina is found to be of frequent occurrence in the mineral waters of this State.†

To ascertain as to whether alumina will be present in the ash of wheat grown on a very sandy soil, a sample of wheat was obtained through the kindness of Dr. Palmer, of Grayling, Mich., where it had grown upon the Jack Pine Plains. The wheat was thoroughly washed, pulverized and burned and treated for alumina as in the other instances, but none was found.

---

*Bread analysis, p. 24.

†Arkansas Geological Survey. Report for 1896, Vol. 1.

In all these analyses the phosphates of iron and alumina were separated from the remainder of the ash by the use of acetate of sodium or ammonium, acetic acid and the temperature of boiling water. To remove other phosphates which were carried down from the concentrated solutions they were dissolved in acid and reprecipitated. These phosphates were then weighed in a platinum crucible in which the filter on which they were collected had been burned. They were then dissolved in the smallest possible quantity of hydrochloric acid, and the solution made to 100 c. c. 10 c. c. of this solution was placed in a Nesslerising cylinder containing one cubic centimeter of strong nitric acid. Two cubic centimeters of ammonium sulphocyanid of the usual reagent strength was added and the contents of the cylinder made to the 50 or 100 c. c. mark. Other Nesslerising tubes were filled in like manner, except that in place of the solution to be analyzed different quantities of a solution of ferric chloride containing .0001 grams of iron to each cubic centimeter were used. By carefully comparing tints in the different cylinders, the number of one-tenth milligrams of iron in the 10 c. c. of solution compared may be readily ascertained.‡ This has been found to be a very ready and satisfactory method of estimating the small quantities of iron contained in these ashes. The alumina was computed from the aluminum phosphate found by difference. The presence of the alumina was also verified by the usual qualitative methods.

OCCURRENCE OF ZINC IN THE ASH OF SOME PLANTS.

Certain ash elements are found in all plants and are essential to their development. Other elements which are only occasionally present in soils may be taken up by plants growing on them though they may have no effect upon the growth of the plant. Among these are manganese, copper, zinc and even arsenic. Their presence is a matter of interest and their general distribution seems a question worthy of some attention. Animals and human beings using the plants for food may accumulate the metals in their system and the discovery of their presence by those unacquainted with their frequent occurrence might lead to various complications, such as the apparent proof of supposed criminal poisoning when none had really occurred.

The finding of zinc in this wheat was quite unexpected. Though the section of country in which the wheat was grown shows to the most casual observer, characteristics in common with some regions in Southern Missouri, where zinc is obtained in abundance, zinc has never been found in paying quantities in this vicinity. The history of the wheat was sought out and a sample of the first 6 inches of soil in the field in which it was grown was obtained. This surface soil is, when dry, of a light mouse color. In quality it is a clay loam containing when taken from the field, a few gravel stones of considerable size. The deep subsoil is heavy clay of yellow or reddish yellow color. The sifted air dry soil yielded to hydrochloric acid .42 per cent of zinc oxide, equal to 7.8 pounds of metallic zinc per ton.

---

‡Bread analysis. Wanklyn and Cooper, p. 34.

Two samples of wheat grown on opposite sides of this first field were taken soon after they were cut in the summer of 1895. The ash of one was found to contain .30 per cent of zinc oxide and of the other .12 per cent, the latter being only one-half of that found in the ash of the wheat milled. Among the mill products of this latter wheat it was found most abundantly in the contents of the dust room which is made up largely of the outermost coat of the bran. The next greatest quantity was found in the ash of the ship stuff and the least in the ash of the flour. No zinc oxide whatever was found in the ash of 100 grams of the straw from one of the above wheats and none in the ash from 50 grams of the other straw. Red clover growing on the field which produced the wheat in 1894 showed .004 g. zinc oxide in the 7.449 g. of a very pure ash from 115 g. of the entire plant. This corresponds to .06 per cent of zinc oxide in the ash of the clover. Corn fodder cut from an adjacent field before tasseling and when about 3 feet high, showed .0065 grams of zinc oxide in the 8.670 g. of ash from 90 g. of the air dry fodder. This corresponds to .07 per cent of zinc oxide in the ash of the corn fodder. This ash was, however, a little dark and contained a little carbon, the amount of which was not determined. A sample of ripe oats grown on a field not far away contained .12 per cent of zinc oxide in the 2.840 g. of a very light gray ash from 100 g. of the grain. Here again no zinc was found in the straw. It would seem, therefore, that as the plant ripens the zinc is transferred to the outer portion of the grain produced.

Frequent mention has been made of the presence of zinc in a small plant (*Viola calminaria*) which grows in the vicinity of zinc mines in Europe. It is written[1] that the growth of this plant has been taken as an indication of the presence of zinc and that when made to grow upon a soil which contains no zinc it undergoes a change of form and color. Lechartier and Bellamy,[2] of France, investigated the presence of zinc in the ash of certain plants, animals, and their products. They found it in notable quantities in the livers of two men of different occupations and dying of different diseases. They also found it in veal, beef, the eggs of poultry and in the grain of wheat, barley, maize, harcot beans and winter vetch. They also examined for it the sugar beet, the stems of corn and green clover and were not satisfied of the presence of zinc in these. In their determination of zinc, as well as in those made here, care was taken that the zinc could not come from any other source than the material examined. The presence of zinc in considerable quantities in many plants has been verified by Sachs and by still others.

---

[1] *Encyclopedie Chemique*, t. x., p. 97, and *Annales Agronomiques*, t. x., p. 478.
[2] *Comtes Rendus*, t. x. LXXXIV. No. 15, p. 687.

Ant. Beaumann[3] has grown various plants in solutions containing salts of zinc and all mineral matters necessary for the development of the plant. He found that when the zinc present did not exceed one milligram per liter of water, the plants grew very well and that the zinc was absolutely inoffensive. When the amount of zinc was increased to about five milligrams per liter it became a poison and the plants soon perished. When solutions of either sulphate or carbonate of zinc were so strong as to destroy plants having their roots in them they had no evil effect when added to a soil upon which similar plants were growing. This is attributed to the precipitation of the zinc from solution by the presence of certain of the soil ingredients, thus rendering it much less capable of entering the roots of the plant. This author attributes the injurious action of the zinc to its attacking the chlorophyll. He also cites the experiments of M. Raulin, in which it was found that the presence of a small quantity of zinc had a decided beneficial influence upon the growth of black mould (*aspergillus niger*). This plant contains no chlorophyll.

So far as known the presence of zinc in plants exerts no influence upon animals consuming them, and it is stated upon the authority of E. Mylins[4] that water of a certain public well of Europe which contains .007 grams of zinc oxide per liter has been used for drinking purposes for more than a century without any perceptible injury to man or beast.

---

[3] *Die Landswirtschaftichen Versuchsstationen*, XXX. volume 1er. fascicule. Abstract in *Annales Agronomiques*, t. x., p. 478.

[4] Chemical News, vol. XLII, p. 49.

THE QUANTITATIVE SEPARATION OF WHEAT PROTEIDS.

Extensive investigations have been made and much has been written* by various experimenters concerning the presence of amides in plants, especially young and immature ones, and concerning the formation of amides during the sprouting of seeds and of their later transformation into proteids in the growing seedling. Extensive investigations have also been made concerning the character and composition of proteids in plants, especially in mature grains and seeds, but so far as known no efforts have been made to study the relative formation and decomposition of such proteids which normally take place in seeds during their development and germination, nor does any extensive investigation seem to have been made concerning the relative proportion of different proteids in like grains or seeds of different characteristics such as often occur in plants of the same species when grown under different conditions as to soil, climate, seasons, etc. While such knowledge concerning the proteids of any agricultural plant gives promise of being of ultimate value to the science of agriculture it seems likely that a knowledge of the kind indicated concerning the proteids of wheat will be of special value because of the probable close association of these variations with the milling qualities of the grain and the consequent value for baking purposes of the flours produced. It seems probable that the relative proportions of the different proteids may bear close relations to well recognized characters of the grains.

The nature and amount of gluten contained in wheat flour frequently gives important information concerning the quality of that flour. It also gives some information concerning the value of a wheat for flouring purposes and more or less use has been made of knowledge concerning it in selecting varieties of wheat for growing in special localities. The mechanical methods of separating gluten which are now extensively used are acknowledged to be very imperfect and unsatisfactory and it seems that a a short but definite chemical method of ascertaining the amount of gluten in wheat or flour will be of great value to the chemist in his examination of those articles.

The important work of Osborne and Voorhees in the Connecticut Experiment Station has given definite information concerning the kinds of proteids in sound mature wheat. Accepting for the most part their classification of these proteids an effort has been made to perfect a ready method of quantitative separation for the purpose of obtaining such information as has been indicated, including a method for the determination of gluten. The matter did not prove as simple as it at first seemed, and it is hardly possible in this report of progress to go beyond a description of the proposed method of analysis, giving in connection therewith the more important analytical data which led to the selection of the method of analysis and, by way of illustration, the results of a few proximate analyses of the proteids of a few different wheats and flours.

---

* For review and bibliography concerning studies on Asparagin up to 1879 see paper by M. Campus *Annales Agronomiques*, t. V. p., 578.

In as much as the following work is based almost entirely upon the characteristics of wheat proteids described by Osborne and Voorhees, and as a record of their work may not be readily accessible to all readers, the names and descriptions of these proteids as given by them in the Report of the Connecticut Agricultural Experiment Station for 1893, (p. 175, 185) are here repeated. With exceptions hereafter noted the presence in wheat and flour of proteids having the characteristics described by them have been frequently verified in the laboratory here, though no effort has been made to show their identity in composition.

"I. *Gliadin* is the proteid which is readily dissolved from wheat flour and from gluten by hot dilute alcohol. * * * In absolute alcohol gliadin is entirely insoluble, but dissolves on adding water, the solubility increasing on adding water up to a certain point and then diminishing.

"II. *Glutenin*. Characteristics of a proteid which can be dissolved only in dilute acids or alkalies are necessarily very few in number. * * * * It (is) probable that glutenin is slightly soluble in water and alcohol, especially if these are warmed.

"III. *Edestin*, a *globulin* belonging to the vegetable vitellins, soluble in saline solutions, precipitated therefrom by dilution and also by saturation with magnesium sulphate or ammonium sulphate, but not by saturation with sodium chloride. Partly precipitated by boiling but not coagulated at temperatures below 100°.

"IV. *Leucosin*, an *albumin* coagulating at 52°; unlike animal albumin in being precipitated on saturating its solution with sodium chloride or magnesium sulphate. It is not precipitated on completely removing salts by dyalysis in *distilled* water.

"V. A *proteose*, precipitated (after removing the globulin by dyalysis and the albumin by coagulation) by saturating the solution with sodium chloride, or by adding 20 per cent of sodium chloride and acidifying with acetic acid.

"VI. The solution filtered from the solution just described (V.) still contained a *proteose-like-body* which was not obtainable in a pure state.

"The results obtained by us and described at length in our paper*, lead to the conclusion that no ferment action is involved in the formation of gluten; that but two proteid substances are contained in the gluten, the gliadin and the glutenin, and that these exist in the wheat kernel in the same form as in the gluten, except that in the latter they are combined with water in an amount equal to about twice the weight of the water-free proteids."

**Am. Chem. Jour.*, 15, 392, 471.

An examination of the characteristics of these proteids as described above, and more fully in the publication cited, led to the belief that all nongluten nitrogen will be dissolved from wheat meal by thoroughly extracting with 10 per cent salt solution, and that the gluten nitrogen will remain undissolved.

The first method attempted for the separation of these two classes of proteids was to place two grams of the material in a 500 c. c. Kjeldahl flask, mix thoroughly by shaking with a small quantity of 10 per cent salt solution, then adding the remainder of 100 c. c. of the liquid. The contents of the flask were shaken at intervals for three hours and then filtered on a 10 c. m. filter of good quality, washing four times with 25 c. c. of salt solution each time. The filter and contents were then carefully returned to the flask and the nitrogen in them determined by the usual Gunning modification of the Kjeldahl method. Duplicates agreed closely. The results were, however, unsatisfactory as appears from the following:

Different strengths of salt solution were used on a sample of straight flour containing 1.82 per cent of total nitrogen, with results as indicated below.

Per cent in sal solution	15	10	5	2½	2	1½	1	½
Per cent nitrogen	1.56	1.50	1.43	1.33	1.30	1.29	1.29	1.30

Similar results were obtained on another sample of flour.

Comparison was made on a complete series of mill products by using a 10 per cent and a 1 per cent salt solution. The per cent nitrogen in each residue, based on the original 2 g. of substance is shown.

	Patent Flour.	Straight Flour.	Low Grade.	Dust Room.	Ship Stuff.	Bran.	Wheat.
10% salt solution	1.28	1.45	1.92	1.49	1.91	1.63	1.51
1% salt solution	1.07	1.25	1.77	1.43	1.78	1.60	1.34
Difference	.21	.20	.15	.06	.13	.03	.17

A further trial was made in which each of another series of mill products was washed fifteen times with a 1 per cent salt solution. The comparison with the results from washing four times, using the same strength of salt solution is shown in the next table. Figures show per cent nitrogen in undissolved residue based on weight taken for analysis.

	Patent Flour.	Straight Flour.	Low Grade.	Dust Room.	Ship Stuff	Bran.	Wheat.
Washed four times	1.15	1.28	1.52	1.42	1 56	1.61	1.39
Washed fifteen times..	.91	.98	1.19	.87	.94	.94	.95
Difference	.24	.30	.33	.55	.62	.67	.44

The filtrate at the end of the fifteenth washing still showed the presence of proteids. This last trial seems to indicate that a considerable quantity of the gluten of flour is removed by continued washing and that the same will occur to a considerable extent in the mechanical washing out of crude gluten. The long time required for this washing may have brought about some change in the form of proteids such as would tend to make the insoluble more soluble. Perfectly concordant though not so marked results were obtained by less protracted washing.

The foregoing method of separating the gluten from the nongluten having been found subject to such serious objections, the following method, which it was believed would obviate the difficulty to a considerable extent, was substituted for it.

Two grams of the material to be examined are put into a 200 c. c. graduated flask and after mixing thoroughly with a 10 per cent salt solution the flask is filled to the neck with the same liquid. The contents of each flask are then shaken at intervals of ten minutes for one hour. At the end of this time the flask is filled to the mark, the contents well mixed and the whole is allowed to remain quiet for two hours. At the end of this time the supernatent liquid in the flask is filtered through a dry filter into a dry flask. If the filtrate is not perfectly clear the first portion is refiltered through the same filter. When sufficient clear filtrate has been collected exactly 100 c. c., measured in a pipette, are run into a 500 c. c. Kjeldahl digestion flask of the usual pear shaped form with long neck. To this solution 20 c. c. of the usual sulphuric acid used for Kjeldahl work are added. The contents of the flask are brought to a gentle boil and when the water has been driven off and the acid has quit foaming, the sulphate of potash is added and the digestion completed. Results obtained by this method agree quite closely with those of the preceding method when using the same strengh of salt solution and washing four times.

The amount of nitrogen obtained in the above process is computed to per cent on one gram of substance. If our hypothesis be true that the salt soluble nitrogen compounds correspond to those not gluten, and those only, the difference between the per cent of nitrogen in the salt extract and the per cent of total nitrogen in the sample will give the per cent of nitrogen which is present in those proteids which together form gluten, and this per cent of nitrogen multiplied by 5.7 will give the theoretical amount of gluten in the material examined.

Numerous estimates of gluten in different grades of flours and wheat meal have been made by the above described chemical method, and on corresponding samples by determining the amount of nitrogen in crude gluten washed out by the usual mechanical process. The mechanical washing out of the gluten has been done entirely by Mr. Moore with great care. The amount of gluten found by the above described chemical method is higher, and in the lower grades of flour much higher than by the usual mechanical method followed by a nitrogen determination. That is, by computing the true gluten from the nitrogen contents of the crude gluten obtained. The proportion of impurities in the crude gluten, especially that from low grade flours is also large, so that decidedly erroneous results would be obtained by the mechanical method unless the crude gluten be submitted to analysis and the impurities determined. When considering the large amount of time and labor involved this is decidedly objectionable. Furthermore, the question still remains, does this give the true gluten in the sample examined? It will be shown later that the chemical method proposed above gives results which are decidedly too low, making the error for the gluten obtained by the mechanical method still greater than appeared from the above comparison. The cause of the error can be better explained and more readily understood after a consideration of the next topic.

DETERMINATION OF THE GLIADIN.

An attempt has been made to separate the gliadin of wheat by a quantitative method which can be readily applied to various samples. After some more or less unsatisfactory attempts the following* has been found a more or less ready means of this separation or at least a ready means by which all proteids soluble in hot 75 per cent alcohol can be extracted.

One gram of the material to be examined is put into a 500 c. c. Kjeldahl digestion flask. 100 c. c. of 75 per cent alcohol, free from nitrogen compounds, are added and after shaking thoroughly the flask is placed upright upon a suitable sized ring of an ordinary water bath. The one used here contains holes for eight flasks. The water bath is heated so as to keep the temperature of the alcohol just below its boiling point. The contents of the flasks are shaken at intervals during the first hour. They are then allowed to remain quiet for one hour, after which the hot, clear liquid can be decanted onto a 10 c. m. filter of good quality. 25 c. c. of hot alcohol are then added to the residue and it is again placed upon the flask for ten minutes before filtering. This is repeated six times. It has been thought best in some instances to completely remove all alcohol from the flask after the last washing and the adding of the well drained filter. This may be readily done by placing the flask on or within the water bath and driving out the vapor by the assistance of a syringe bulb connected with a glass tube or by connecting the glass tube with an ordinary Richards' air blast. The presence of the alcohol has sometimes given trouble during the subsequent digestion in removing a large part of the acid by volatilization of the resulting compound.

---

*Since the method here described has been in use, the second edition of Chemistry and Analysis of Wheat, Flour, etc., by William Jago, has been received. In it (p. 789) he describes a method for determining proteids soluble in alcohol, which perhaps requires a little less labor than the one proposed in the text, but it is quite certain from comparisons made that results for gliadin obtained in that way will be much too low.

After the alcohol has been removed the nitrogen is determined in the usual way, care being taken that all particles adhering to the neck of the flask are washed down by the acid and digested. It is necessary in this instance to determine the nitrogen in the filters used and deduct it from the results. The difference between the total nitrogen and the nitrogen thus obtained gives the per cent of nitrogen in the alcohol extract. This also includes amides as will be shown later.

A more ready method of obtaining the nitrogen contents of the alcohol extract is to collect the filtrate directly into a Kjeldahl flask. Place the flask on a sand bath and properly adjust it to a Leibig condenser. The greater part of the alcohol can thus be distilled off in a short time without fear of accident. The last portion of the liquid may be readily removed by placing the flask on a boiling water bath and inserting into the neck a glass tube connected with a filter pump or air blast. By using one of these for each of two flasks a single water jet is made to do double duty. The neck of the flask connected with the blast should be allowed to drop nearly to the horizontal. After evaporating to dryness the nitrogen is determined in the usual way.

Osborne and Voorhees suggest, as already noted, that it is possible that glutenin is slightly soluble in hot water and alcohol. There is always a greater or less cloudiness to the liquid when the alcohol extract, obtained as described above, becomes cold. Among mill products this increases gradually from the finest flours to the bran. Pure germ, when extracted with hot alcohol, gave an extract which was very clouded, though the amount of proteid in solution by no means equaled the amount of gliadin which has been found in an equal amount of cold, perfectly clear, alcohol solution. It is possible that a proteid having this characteristic may exist in the germ. The general characteristics of this portion of the grain differ so greatly from the remainder that it seems quite possible that the proteids of the two portions should differ.

A sample of the pure handpicked germ when submitted to the methods for separation of proteids which have been described above gave the following results: The total proteids (N x 5.7) were 37.55 per cent. Those soluble in salt solution were 15.33 per cent and those soluble in hot 75 per cent alcohol were 2.85 per cent. Another sample of germ contained 36.02 per cent of total proteids. The ether extracts in the two samples were 13.85 and 14.38 per cent respectively.

THE PROTEOSE.

On comparing the use of a 10 per cent and the use of a 1 per cent salt in the methods described for the determination of the salt extract it was found that, as indicated by the first method, there was a notably larger extract by the 1 per cent than by the 10 per cent salt solution, and a much greater decrease was found when a 20 per cent solution of salt was used. Thus a sample of low grade flour gave the following results: One per cent salt extract contained .66 per cent nitrogen, 10 per cent salt extract contained .48 per cent nitrogen, 20 per cent salt extract contained .20 per cent nitrogen to each gram of material extracted.

With the hope of finding the true cause of this feature of the question a considerable quantity of perfectly clear 1 per cent salt extract of wheat meal was obtained. To this a sufficient quantity of dry salt was added to make a 10 per cent solution. A considerable precipitate was produced and this was found to be largely soluble in 75 per cent alcohol in a clear solution of which proteids were readily detected.

If the proteids, or a portion of them, which are soluble in salt solution are insoluble in alcohol they should be precipitated by the addition of alcohol. When 50 c. c. of the clear, filtered 1 per cent salt extract were mixed with sufficient strong alcohol to make the resulting mixture contain about 75 per cent, a considerable white flocculent precipitate was produced, which soon settled, giving a supernatent clear liquid. This filtered rapidly and gave a perfectly clear filtrate. The rapidity of flocculation of the precipitate was increased somewhat on heating. The concentrated filtrate gave strong biuret reaction. In like manner a marked biuret reaction for proteids was obtained by concentrating 100 c. c. of alcohol filtrate when the added alcohol was such as to make 90 per cent of alcohol in the mixture.

In following out this line of investigation, a solution was made by mixing 100 grams of wheat meal with 500 c. c. of 1 per cent salt solution, shaking at intervals for one hour and filtering at the end of three hours. The proteids insoluble in 75 per cent alcohol were precipitated from 40 c. c. of this perfectly clear filtrate by adding alcohol to make a mixture of the desired strength. An aliquot portion of the resulting clear alcoholic filtrate, corresponding to 20 c. c. of the original salt solution, was evaporated to dryness in a Kjeldahl flask and a determination made of the amount of nitrogen. Similar nitrogen determinations were made when a 10 per cent, and later a 15 per cent salt solution was used for extracting like quantities of the same wheat. In this manner is found the number of milligrams of nitrogen in the nitrogen compounds soluble in alcohol from 20 c. c. of the salt solutions of the various strengths. Determinations of the total nitrogen contents of each of these salt solutions was also made and computed to milligrams in each 20 c. c. of solution. The results of both of these series of determinations are shown below.

	Total Nitrogen. m. g.	Alcohol Soluble Nitrogen. m. g.
1 per cent salt solution	19.48	9.7
10 per cent salt solution	18.6	8.8
15 per cent salt solution	16.2	7.6

It was found later that a part of this alcohol soluble nitrogen is from amides, but the amount of amides in the wheat was by no means sufficient to account for the whole of the nitrogen thus obtained, and furthermore, abundant indications of proteids were found in each case by suitably concentrating the alcoholic filtrate and applying the biuret test.

A further comparison of the extracts made by 1 per cent and by 10 per cent salt solutions was made as follows: Salt extracts were made in 200 c. c. measuring flasks as already described, except that four grams of the material were used so that 50 c. c. of the extract would correspond to one gram of the sample. This quantity of extract was mixed with 250 c. c. of strong alcohol and allowed to stand over night. Nitrogen was then determined in both the filtrates and the precipitates with the following results:

Precipitated by Alcohol.	Per Cent Nitrogen.
1 per cent salt solution	.21
10 per cent salt solution	.23
Soluble in Alcohol.	
1 per cent salt solution	.42
10 per cent salt solution	.27

A similar trial on a sample of ship stuff gave results as follows:

Precipitated by Alcohol.	Per Cent Nitrogen.
1 per cent salt solution	.31
10 per cent salt solution	.31

It seems clear that the difference in amounts of nitrogen compounds removed from wheat by 1 per cent and by 10 per cent salt solutions is due to such as are soluble in 75 per cent alcohol. Filtering hot did not materially affect the results.

A strong alcoholic solution of wheat proteids was made by mixing the meal with cold 75 per cent alcohol. On pouring this clear extract into 1 per cent salt solution a precipitate was produced which, when filtered off, gave a perfectly clear filtrate. Proteid in considerable quantity was detected in this liquid by various reactions. Furthermore, the liquid was found to give the reactions characteristic of proteoses: Not coagulated by heat; a precipitate with nitric acid which disappears on warming; a like reaction with potassium ferrocyanide and acetic acid; precipitation by 20 per cent sodium chloride and acetic acid. Authorities* also state that proteoses are precipitated by alcohol. Either this proteid is somewhat soluble in alcohol or it is the result of the decomposition of a proteid which is soluble in that liquid brought about by mixing with the 1 per cent salt solution. If it be the latter, what is the explanation of the alcohol soluble portion of the salt extract? When the alcohol solution of this proteid is concentrated it also exhibits the properties of proteoses mentioned. When this alcohol solution of the salt extract is concentrated somewhat it exhibits the character of gliadin solutions in alcohol in that it is precipitated either by the addition of water or of strong alcohol.

A sample of fresh gluten was treated with hot 75 per cent alcohol and 10 c. c. of a resulting concentrated extract were poured into 90 c. c. of 1 per cent salt solution and a precipitate formed. This on the following morning was filtered off and, by sprinkling a little pure, fine animal charcoal on the wet filter, a perfectly clear filtrate was obtained. This filtrate contained a proteid exhibiting the same proteose reactions mentioned above.

---

*Chittenden, Digestive Proteolysis, p. 62; Hammarsten, Physiological Chemistry, p. 26.

Some months previous a sample of gliadin had been prepared, at least nearly pure, by precipitating the concentrated 75 per cent alcohol solution with absolute alcohol, and washing well with alcohol and ether, after which it was dried in vacuum over sulphuric acid. A 75 per cent alcohol solution of this was prepared, which, when poured into a considerable quantity of 1 per cent salt ~~extract~~ solution gave the usual precipitate. A clear filtrate, obtained without the use of animal charcoal again exhibited the proteose reactions.

On a succeeding page (p. 95) is given a series of results obtained on about twenty samples of different wheats and parts of wheat in which it is shown that when like amounts of wheat or its mill products are treated under the same conditions with equal amounts of 1 per cent salt solution, the amount of alcohol soluble proteid removed from the wheat in the 1 per cent salt solution is practically identical. Many results, which it is thought unnecessary to give, show that the same would have been true if 10 per cent salt solution had been used, except that the quantity thus extracted would have been less. There is a great variation in the amounts of the other nitrogen compounds contained in these various samples. The only reasonable explanation of these facts seems to be that an alcohol soluble proteid which is slightly soluble in 1 per cent and less in 10 per cent salt solution exists in considerable quantities in the wheat.

It seems evident that this proteid is gliadin and it appears from the behavior described that gliadin is not changed when it is dissolved in salt solution but that it remains gliadin. With the exception of being readily soluble in 75 per cent alcohol and but slightly soluble in weak salt solutions, it possesses what have been set aside as the characteristic reactions of proteoses. Apparently it was this body which was found by Osborne and Voorhees in their salt extracts and was designated by them as a proteose and a proteose-like body under captions V. and VI.

In its alcohol solution (75 per cent) gliadin has not been found to exhibit the reactions of proteoses with common salt. The addition of large quantities of salt in bulk to such a solution was found not to cloud it in the least either with or without acetic acid. When salt in solution is added a precipitate will be produced but in such cases it seems to be attributable, in part at least, to the dilution of the alcohol with water. It has been pointed out by the authors named above that gliadin is soluble in considerable quantities in pure water but is precipitated from such solution by the addition of a very small quantity of salt. The experiments recorded above show that the precipitation is not complete.

This solubility of gliadin in salt solutions accounts for the fact that when flour is treated directly with large quantities of salt solution no gluten is formed. It also has an important bearing upon the determination of gluten in wheat or flour by the usual mechanical method of washing away the starch and weighing the residue.

Twelve grams of Porter's "standard" flour, from spring wheat, was made into a dough with 10 c. c. of 1 per cent salt solution and allowed to stand for one hour. It was then tied in a linen cloth and worked between the fingers in one liter of the same salt solution for one hour. It having been found impossible to obtain a clear filtrate from the solution direct it was heated nearly to the boiling point. One hundred and seventy-five c. c. of a nearly clear filtrate from this were evaporated to about 30 c. c. and enough strong alcohol added to make the mixture contain 75 per cent. Ten c. c. of perfectly clear filtrate from this showed much cloudiness on adding a few drops of a solution of phospho-wolframic acid which cloudiness precipitated on standing. The remainder of the alcoholic solution when concentrated gave in repeated trials distinct biuret reaction for proteids,* the same rose color being exhibited as when gliadin is treated.

It has been already pointed out that the so-called true gluten obtained by mechanical washing away of the starch and computing the remaining proteids from the nitrogen contents of the crude gluten obtained gives results which are much too low when compared with the sum of the gliadin and glutenin in the sample examined. The explanation is here apparent. An indefinite amount of gliadin is dissolved and washed away. In view of this fact the mechanical method of determining gluten in wheat and flour is even more unsatisfactory than has formerly been thought.

EDESTIN AND LEUCOSIN.

If a perfectly clear 1 per cent salt solution extract of wheat be heated slowly to about 50 c. a cloudiness will begin to appear and if the liquid be kept at about 60 for some time a considerable quantity of flocculent precipitate separates out. If this be filtered off and to the perfectly clear filtrate alcohol be added a still further precipitate occurs, which is less than when alcohol is added to the unfiltered solution. According to the descriptions of edestin and leucosin given by Osborne and Voorhees this is what would be expected if these two proteids are in the alcohol precipitate of the salt extract. It is difficult to determine what strength of alcohol will produce complete precipitation of these proteids. From a considerable number of trials, the details of which it seems unnecessary to give here, it is believed that a strength of 75 per cent alcohol produces at least nearly complete precipitation, but it does not appear safe to stop short of that strength. It is not safe to increase the strength to 90 per cent for fear of precipitating the gliadin.

---

*The delicacy of the biuret reaction for this proteid may be increased by using a very small quantity (2 c. c.) of the concentrated solution, an equal amount of the strongest caustic potash solution, and, after adding the few drops of copper sulphate, adding also about one cubic centimeter of strong alcohol. After shaking the mixture gently the color will be concentrated in the clear alcohol which rises to the top.

The readiness with which these proteids can be separated from the liquid in which they are precipitated, suggests that they might be collected in a Gooch crucible, washed, dried and weighed in bulk. The precipitation from so large a bulk of liquid would seem to leave them quite pure. At least part of the precipitate caused by alcohol will not be redissolved when the alcohol is decanted and an excess of 1 per cent salt solution added. This change in solubility may be accompanied by a slight change in composition.

AMIDES.

To ascertain concerning the solubility of amides in 75 per cent alcohol 200 m. g. of asparagin (pure. E. Merck) were dissolved in 50 c. c. of 1 per cent salt solution. This solution was mixed with the usual amount of strong alcohol used for precipitating proteids from a like quantity of solution. A slight precipitate occurred which seemed to become more crystaline on boiling. The liquid was allowed to cool thoroughly before filtering. The filtrate was collected in a Kjeldahl flask and the alcohol removed by boiling and evaporation on a water bath. A considerable quantity of asparagin crystals remained. On determining the nitrogen in the usual manner, a quantity was found equal to that contained in 25.7 c. c. of $\frac{N}{10}$ ammonium hydrate. This is much in excess of the total nitrogen obtained from any sample of wheat examined. Allantoin,* another amide of wheat, is also soluble in alcohol. The amides, then, may be assigned to the alcohol solution, whether from the salt solution or from the original sample.

In attempting to make a complete separation of the proteids of wheat based upon the amount of nitrogen found, a determination and location of the amides present is important. To that end it is assumed that in the sound, mature wheat all nonproteid nitrogen exists in the form of amides.

The "official method" for the determination of the albuminoid nitrogen has been found deficient for wheat in this respect: It directs, "If the substance examined consists of seed of any kind, add a few cubic centimeters of a solution of (potash) alum just before adding the cupric hydrate and mix well by stirring." The following results with and without alum were obtained on a sample of wheat meal.

---

* Watts' Dictionary of Chemistry, Vol. 1. 1893.

	Per Cent Albuminoid Nitrogen.
Copper hydrate and 0 c. c. alum solution	1.53
Copper hydrate and 5 c. c. alum solution	1.37
Copper hydrate and 10 c. c. alum solution	1.35
Copper hydrate and 15 c. c. alum solution	1.35
Copper hydrate and 20 c. c. alum solution	1.32

The depth of blue color in the filtrate increased directly with the amount of alum used. That with no alum was almost colorless and that with 20 c. c. of alum had a strong blue tint. When no alum was used the filtrate showed but slight turbidity with a solution of phospho-wolframic acid while the others showed abundant precipitates.

As suggested by P. P. Deherain,* phospho-wolframic acid was tried as a precipitant for the proteids, conducting the remainder of the experiment as when copper hydrate is used. In a few instances results were obtained which are fairly concordant with those given by the copper hydrate method. Generally, however, in wheat meals and flours the liquid filters badly and it was found almost impossible to obtain a clear filtrate. In later work it was found that when a solution of phospho-wolframic acid is added to a salt extract made as has been described, a precipitate occurs, which, when left over night, gives a clear supernatent fluid which filters readily and leaves a perfectly clear filtrate. On collecting this (50 or 100 c. c. with a few cubic centimeters of washings) in a Kjeldahl flask and adding 20 c. c. of concentrated sulphuric acid the water can be readily boiled off, especially if the flask be protected from the naked flame with a thin sheet of asbestos. When the acid ceases to foam it is cooled slightly, sulphate of potash added and the nitrogen determination completed in the usual way. After adding the sulphate the time required for the digestion is but a few minutes.

The readiness with which the water may be driven off and the digestion completed in this way makes it preferable to determine the nitrogen in the filtrate when the albuminoid nitrogen is precipitated by copper hydrate as in the official method. The difference between the nitrogen found and the total nitrogen of the sample gives the amount of albuminoid nitrogen with equal accuracy, while the time of digestion is much shortened, the danger of breakage is lessened and the necessity for making a correction for the nitrogen in the filters is prevented. The only requirements are that the water and reagents shall be free from an appreciable quantity of ammonia or other nitrogen compounds, and this is equally essential in all Kjeldahl work.

---

*Traite de Chimie Agricole, p. 267.

AMOUNT OF GLIADIN IN SALT EXTRACTS OF WHEATS AND FLOURS.

The results of a separation of the nitrogen compounds in the 1 per cent extract of a considerable number of samples of wheat, flour, etc., are given below. The separation has been made by the above methods. Precipitation of edestin and leucosin in alcohol of 75-80 per cent strength; determination of the amide or nonproteid nitrogen in the filtrate after precipitating with phospho-wolframic acid; estimating the soluble gliadin nitrogen by difference. A systematic arrangement of details of procedure are given on a subsequent page.

Alabama

Agricultural Experiment Station

24750

Annual Reports

8th — 1895

12 — 1899

University of Chicago

[illegible] Library

conditions of the experiment. Four results vary to a considerable extent from the average of the other sixteen. Of these, one is the sifted dust room contents which consists of the outermost portion of the bran. The nitrogen here obtained is .14 per cent. The nitrogen in the direct alcohol extract of this sample was .36 per cent. Of this, .20 per cent should be credited to amides. The difference, or .16 per cent, represents that from the total gliadin in the material, and shows why a greater amount was not extracted by the salt solution. That gliadin is contained in the alcohol extract from this sample was verified by suitable reactions. Two other samples showing an unusually low difference are white wheats, each of which contains a very low per cent of gliadin. The remaining irregular sample is an Arkansas red wheat of the harvest of 1894. These include all samples which have been examined in this way. The mean difference for all samples, excluding dust, is .27 per cent.

The foregoing results seem to justify the proposing of a method for the determination of the gluten in wheat and flour based upon the subtraction of a constant factor from the nitrogen found in a 1 per cent salt solution, which otherwise represents the nongluten nitrogen contained in the material. One per cent salt solution is preferable to a 10 per cent solution, in that it is more satisfactory in certain points of manipulation. Based upon the work done, the provisional factor of .27 per cent is proposed. The results indicate that another might be more applicable to a certain class of wheat. The work done is not sufficient to give definite conclusions on that point.

The results of the foregoing work may be summed up in the following:

METHODS FOR QUANTITATIVE DETERMINATION OF WHEAT PROTEIDS.

Total Nitrogen. The Gunning modification of the Kjeldahl method has been used throughout this work. More concordant results have been obtained with one gram of material than with two grams.

Nongluten Nitrogen. Put five grams of the material to be examined into a 250 c. c. measuring flask. Add about 15 c. c. of a 1 per cent solution of sodium chloride and shake thoroughly. To the resulting homogeneous mass add enough of the same solution to fill the flask nearly to the neck. Shake the contents of the flask at intervals of ten minutes during one hour. Fill to the mark with salt solution, mix thoroughly and let stand for two hours. Decant the liquid onto a 12½ c. m. dry filter of good quality, leaving the greater bulk of the solid material in the flask. The filtrate will be clouded, but if refiltered through the same filter into a clean flask it will generally be perfectly clear. Determine the nitrogen in 50 c. c. of this extract, noting precautions on page 93. From the per cent of nitrogen thus obtained subtract .27 per cent as corresponding to the nitrogen obtained from the gliadin soluble in 1 per cent salt solution under the conditions prescribed above. The remaining per cent of nitrogen is that corresponding to the nongluten nitrogen in the sample examined.

Gluten Nitrogen. This is the difference between total nitrogen and the nongluten nitrogen as obtained above. The gluten nitrogen may also be found by subtracting the sum of the edestin, leucosin and amide nitrogen from the per cent of total nitrogen.

Edestin and Leucosin Nitrogen. To 50 c. c. of the clear salt extract, obtained as described above, add, in a Kjeldahl digestion flask of 500 c. c. capacity, 250 c. c. of pure 94 per cent alcohol (188 per cent proof, redistilled). Mix thoroughly and allow to stand over night. Collect the precipitate on a filter (10 c. m.) of good quality, return to the flask and determine the nitrogen, making proper correction for the nitrogen in the filter.

If desired, these two proteids may be separated by coagulating the leucosin at 60 c. and precipitating the edestin by adding alcohol to 50 c. c. of the clear filtrate as before. The nitrogen in each precipitate may then be determined.

Amide Nitrogen. Precipitate all proteids from 100 c. c. of the clear salt extract obtained as above by adding 10 c. c. of a 10 per cent solution of phospho-wolframic acid, made by dissolving the pure solid in distilled water. Allow to settle before filtering and determine the nitrogen in the clear filtrate. (See page 93.) In case of bran, and perhaps immature or sprouted wheat, it may be necessary to add a somewhat larger quantity of the acid solution to produce complete precipitation of the proteids. In such cases the filtrate should be tested by the addition of a few cubic centimeters of the acid.

Gliadin Nitrogen. Extract one gram of the material with hot 75 per cent alcohol as described on page 85. From the per cent of nitrogen dissolved by the alcohol subtract the per cent of amide nitrogen. The difference will be the gliadin nitrogen.

Glutenin Nitrogen. The difference between the gluten nitrogen and the gliadin nitrogen gives the glutenin nitrogen.

Proteids. The amount of the various proteids may be found by multiplying the per cent of the corresponding nitrogen obtained by 5.7. This factor is deduced from the average nitrogen contents of the proteids of wheat as found in a large number of analyses made by Osborne and Voorhees. It undoubtedly approximates much nearer the truth than the factor 6.25.

Wheat for the above work should be ground so that the endosperm shall pass through a sieve having circular holes of ½ millimeter in diameter. The bran of the grain, being in thin flakes will be sufficiently fine if made to pass through a sieve with circular holes one milimeter in diameter and the work of pulverizing will be greatly lessened. The resulting parts must be thoroughly mixed. The error due to the presence of the undissolved meal in the measuring flask used for the determination of the salt extract is so small that it may generally be neglected. If desired, the flask may be readily remarked for the work by adding to the usual weight of meal in the flask exactly 250 c. c. of the salt extract. In this case care must be taken to wet the meal thoroughly with not more than 25 c. c. of the liquid, after which the remainder of the meal may be added.

SEPARATION OF THE PROTEIDS OF CERTAIN WHEATS AND FLOURS.

Following the plan of separation outlined above a proximate analysis has been made of the nitrogen compounds of certain flours and other mill products and of a few samples of wheat grown in different sections of the country. They are given mainly to illustrate the variations in the relative amounts of the different proteids. That this variation may be more clearly seen, one of the tables shows the nitrogen of the proteids in per cent of the total nitrogen of the sample. The extension of such anylitical work to a large number of samples of wheats and flours of different characters is necessary before definite conclusions can be drawn as to the relation which the different proteids have to those characteristics, and inasmuch as it is a new field of labor, the outcome of such work cannot be foretold.

It has been frequently stated that bran contains no gluten. In the analysis of the sample of bran shown in the table both gluten proteids are shown to be present in considerable quantity. A portion of this gliadin is from adhering endosperm. However, the pure sifted dust, which consists of the outermost portion of the grain, contains a small amount of gliadin. The explanation of the formation of gluten by Dr. Osborne indicates that the presence of the gluten proteids in bran and the nonformation of gluten in the usual mechanical method of separation are perfectly consistent. The true explanation seems to be that the woody fiber of the bran prevents the uniting of the gluten particles into the gluten mass characteristic of flour and wheat meal.

The variation of the nitrogen compounds among different mill products from the same mill are interesting. Among these the gradual increase of amides, of edestin and leucosin and of glutenin from the finest flour to the bran and the corresponding gradual decrease of gliadin are worthy of note. In the series of mill products of which the analyses of the ashes were made, all were from the same wheat. It is pretty certain that those in this series of analyses are not all from the same wheat, which accounts for certain minor variations. All were taken from the mill at the same time and were of recent grinding.

As between the patent flours from winter and from spring wheat the equal amounts of gliadin and the great difference in the amounts of glutenin are suggestive. There may also be a hidden meaning in the very low proportion of gliadin found in the two samples of white wheat examined. A knowledge concerning this and other matters relating to this subject may give information which will be useful in the blending of wheats and flours to improve the quality of the latter. This is now practiced to some extent by bakers and millers upon their knowledge of the general physical characters of the material and it is believed by many to be attended with good results.

TABLE SHOWING NITROGEN OF NITROGEN COMPOUNDS OF WHEAT IN PER CENT OF TOTAL NITROGEN PRESENT.

ARKANSAS MILL PRODUCTS.

Kind of Substance.	Nongluten Nitrogen.	Gluten Nitrogen.	Gliadin Nitrogen.	Glutenin Nitrogen.	Edestin and Leucosin Nitrogen.	Amide Nitrogen.
Patent Flour	8.1	91.9	64.2	27.7	6.4	1.7
Straight Flour	8.6	91.4	54.0	47.4	7.0	1.6
Low Grade Flour	11.8	88.2	50.5	37.7	9.5	2.3
Ship Stuff	17.2	82.8	46.2	36.6	13.0	4.2
Bran	26.3	73.7	23.7	50.0	17.8	8.5
Sifted Dust	26.5	73.5	11.8	61.7	11.8	14.7
PORTER'S FLOURS.						
Souvenir	7.8	92.2	50.7	41.5	5.4	2.4
oooo Boss Flour	7.4	92.6	51.8	40.8	5.1	2.3
Standard Flour	9.3	90.7	51.3	39.4	6.6	2.7
Strong Bakers' Flour	14.7	85.3	45.5	39.8	11.3	3.4
Red Dog	26.3	73.7	27.5	46.2	16.9	9.4
WINTER WHEATS.						
Red, Arkansas	17.3	82.7	48.4	34.3	12.5	4.8
Red, Arkansas (1894)	13.2	86.8	45.7	41.1	8.7	4.5
Currell, Kansas	16.7	83.3	43.2	40.1	11.4	3.4
Zimmerman, Kansas	16.5	83.5	42.4	41.1	11.3	5.2
White Wheat, Canada	20.6	79.4	34.0	45.4	15.6	5.0
Oregon White Wheat	18.7	81.3	34.7	46.5	13.9	4.9
SPRING WHEATS.						
Red Wheat, South Dakota	15.5	84.5	42.6	42.0	10.4	5.0
Red Fife, Minnesota	18.1	81.9	37.9	44.0	13.0	5.1
Red Fife, North Dakota	17.4	82.6	36.4	46.8	12.8	4.6

TABLE SHOWING PER CENTS OF PROTEIDS IN WHEATS AND FLOURS.

ARKANSAS MILL PRODUCTS.

Kind of Material.	Crude Proteids.	Gluten.	Gliadin.	Glutenin.	Edestin and Leucosin.
Patent Flour	9.86	9.06	6.33	2.73	.63
Straight Flour	10.66	9.75	5.76	3.99	.74
Low Grade Flour	12.54	11.06	6.33	4.73	1.20
Ship Stuff	13.57	11.23	6.27	4.96	1.77
Bran	15.39	11.34	3.65	7.69	2.74
Sifted Dust	7.75	5.70	.91	4.79	.91
PORTER'S FLOURS.					
Souvenir	11.69	10.77	5.93	4.84	.63
oooo Boss Flour	12.43	11.51	6.44	5.07	.63
Standard Flour	12.86	11.69	6.16	5.08	.86
Strong Bakers' Flour	15.16	12.94	6.90	6.04	1.71
Red Dog	15.16	11.17	4.16	7.01	2.57
WINTER WHEATS.					
Red Wheat, Arkansas	14.14	11.69	6.84	4.85	1.77
Red Wheat, Arkansas (1894)	12.48	10.83	5.70	5.13	1.08
Currell, Kansas	15.05	12.54	6.50	6.04	1.71
Zimmerman, Kansas	13.17	11.00	5.59	5.41	1.48
White Wheat, Canada	8.04	6.38	2.74	3.64	1.25
Oregon White Wheat	8.21	6.67	2.85	3.82	1.14
SPRING WHEATS.					
Red Wheat, South Dakota	19.15	16.19	8.15	8.04	2.00
Red Fife, Minnesota	12.31	10.09	4.67	5.42	1.60
Red Fife, North Dakota	11.12	9.18	4.05	5.13	1.43

ACKNOWLEDGMENTS.

Thanks are due the following for samples of wheat and flour for this work: The L. C. Porter Milling Company, Winona, Minn.; Prof. E. A. Burnett, Brookings, S. D.; Prof. C. B. Waldron, Fargo, N. D.; Mr. Robert Dawson, Paris, Ont.; Prof. C. C. Georgeson, Manhattan, Kas.; Prof. H. T. French, Corvallis, Ore., and Mr. Andrew Boss, St. Anthony

Park, Minn. Through the kindness of the late Fayetteville Milling Company and of Mr. B. F. Johnson and his son, the data of the various test runs recorded in this bulletin and the various samples of mill products used for analysis, have been procured.

The large amount of analytical and other routine labor which have resulted in that portion of the bulletin relating to the separation of the proteids of wheat, and the making of certain analyses recorded in Part I., have been greatly facilitated by the earnest coöperation of Mr. J. F. Moore, who has faithfully performed all duties assigned to him.

G. L. TELLER.

CHEMICAL LABORATORY, ARKANSAS EXPERIMENT STATION.

APPENDIX.

Since the foregoing pages were sent to press an effort has been made to determine whether or not the proteose bodies found by Dr. Osborne[1] in the water or salt solution extracts of oats, rye and barley, and by Drs. Chittenden and Osborne[2] in similar extracts of maize, may be attributable to characteristics of the alcohol soluble proteids of those grains, such as have been pointed out as belonging to the gliadin of wheat. To that end extracts of each were made with 75 per cent alcohol and with a 1 per cent salt solution.

Of each clear filtered salt solution extract 25 c. c. were mixed with 125 c. c. of 94 per cent alcohol. The resulting precipitates were filtered off and the clear filtrates were each found to possess the following reactions in common with solutions prepared from wheat in like manner: A precipitate upon dilution either with water or with absolute alcohol. A precipitate or cloud with phospho-wolframic acid, which precipitate dissolves on warming and reappears on cooling. Nitric acid does not produce a precipitate in such dilute solutions.

Of each alcohol extract 25 c. c. were mixed with 125 c. c. of 1 per cent salt solution. A clear filtrate from the resulting mixture gave in each case reactions for proteids. The resulting precipitates dissolved more or less completely on warming and reappeared on cooling. With nitric acid this solution from wheat gave a cloud which quickly disappeared on warming. With the rye solution no change was seen until the liquid was cooled with ice. A dense cloud then appeared while a similar tube of the liquid without the acid remained perfectly clear. The cloud disappeared on adding strong alcohol as well as on warming. In the solution from barley a similar but less marked cloud was obtained on cooling with ice. No precipitate with nitric acid was obtained in these dilute solutions from either corn or oats. Certain other reagents gave, in each case, precipitates which dissolved on warming and reappeared on cooling. A nearly clear water solution obtained by mixing the 75 per cent alcohol extract of corn with a large excess of water, gave a precipitate with nitric acid which did not dissolve, but increased on warming. When, however, a quantity of strong alcohol was added to the liquid the precipitate immediately dissolved.

---

[1] Conn. Exp. Sta. Reports, 1890 and 1894.
[2] Amer. Chem. Jour. Vols. XIII and XIV.

With each grain, including wheat, the clear alcohol extract of the meal gave precipitates in the cold with phospho-wolframic acid and with tannic acid, each being in solution in 75 per cent alcohol. In each instance the precipitate dissolved on warming and reappeared on cooling. A similar precipitate was given with nitric acid and the liquid became more or less yellow on boiling. As shown above, the compounds of these proteids with nitric acid are very soluble in dilute alcohol. With phospho-wolframic acid the cloud which at first dissolved reappeared when the liquid was kept near its boiling point for a short time. In the alcohol extract of corn the precipitate with tannic acid is slight, even with much reagent. It is very readily seen if the strong solution of proteid be diluted with an equal bulk of 75 per cent alcohol, sufficient reagent added and the whole cooled with ice.

These facts, in connection with certain others pointed out on previous pages of this bulletin, support the belief that the proteose bodies which have been found in the water or dilute salt extracts of these various grains are really the alcohol soluble proteids, small quantities of which have been carried into solution and exhibit their characteristics unchanged. Furthermore, these alcohol soluble proteids are seen to possess certain properties which have been thought to be characteristic of proteoses.[3]

G. L. TELLER.

Fayetteville, Ark., October 3, 1896.

---

[3] Physiological Chemistry, Charles, (1884) p. 117. Physiological Chemistry, Hammarsten, *Mandel*, (1893) p. 25. Digestive Proteolysis, Chittenden, (1894) p. 62. Watts' Dictionary of Chemistry, (1894) Vol. IV, p. 331.

REPORT OF THE HORTICULTURIST.

John T. Stinson.

STRAWBERRIES.

The trial plots on the Station grounds comprise sixty-seven varieties that fruited this year, and sixteen newer ones that have not yet fruited. Some of the varieties have been in the station plots for several years.

The drouth was very severe on all plots for next year's fruiting. The drouth set in about the time the old beds were worked over, and as the moisture in the soil had escaped, as is usual during the fruiting season, there was none to feed the plants. Strawberry fields over the State have suffered a similar fate. The effects in some fields have been to kill fully three-fourths of the plants. The drouth was much more severe than had been known for many years before. Our trial plots in Pine Bluff and Van Buren suffered in the same manner as those here.

For the purpose of giving some practical information from growers of strawberries, a circular letter of inquiry was sent to them, and the answers are published in these pages. This was done for the purpose of getting information direct from the berry sections. These replies answer in part, at least, the many inquiries that the Station is constantly in receipt of from those desiring information on varieties and methods of culture. They answer the inquiries much better than we can from the experience in testing and growing the varieties here on the Station grounds. The only safe test of varieties is for the grower to make the test himself under the same conditions and on the same soil that he would grow the varieties for market. The variety may be a great success with his neighbor, and on the Experiment Station grounds, but be only a fair success with him. The expense of testing a number of new varieties is considerable to the individual grower. This can be done at the Station, and those especially worthy of trial there may afterwards be tested by growers in the berry sections. A small test plot on every berry farm is a paying investment. The grower is the only person who can ascertain the value of any variety on his place.

For the purpose of giving some general information on varieties the notes taken on newer varieties fruited this year along with some mentioned in previous bulletins will be given.

Arrow (P). This is a seedling of Haverland. The plants are strong and vigorous, foliage healthy. A good plant producer and adapted to matted row culture, stem long; a good crop of large berries, berry pointed, color dark, smooth and fairly even, firm, flavor good. It is fairly promising and deserves further trial.

Belle (P). Plants vigorous, foliage healthy and of a dark color. Stem short, berry large, rather slender, fairly promising, and will be given further trial.

Bisel (P). Is a seedling of the Wilson, plants healthy and a vigorous grower. A good plant producer; berry medium to large, smooth, round and sometimes pointed, color fine rich dark red. It is a promising variety.

Banquet. Stand fair, plants badly damaged by leaf blight, rather inclined to grow in clumps. Berries uneven, some very large while others were quite small, smooth, dark colored, flavor very good. This variety will probably not prove desirable owing to its tendency to leaf blight.

Belmont. Stand good, plants extra strong; foliage but slightly attacked by leaf blight. It set a fair crop of berries which were large and pointed, some very large, fairly firm, color dark. It will be given further trial.

Cyclone. Plants are large and vigorous, foliage healthy. Adapted to growing in matted rows. Stem rather long, berry medium to large, rather pointed, firm, color dark, flavor good. It is a promising variety, but it did not produce a very heavy crop this year, and further trial is necessary to determine its producing qualities.

Columbian. An extra good plant producer; foliage healthy, and rather dark in color; stem long; berry medium in size, some large, the berries are rough and ill-shaped; yield poor. From this year's trial it appears to be undesirable.

Chairs. An extra good plant producer; foliage healthy; stem medium in length. It set a very good crop of fruit this year. Berries large, round, smooth, and even; color light. The berries are too soft for shipment but are good for home use, as the fruit is even and berries all large. Flavor very good.

Enormous (P). Plants healthy, foliage dark colored. Stem long and well filled. Berry large, firm, but inclined to be rough, rather long and some coxcombed. Color light and flavor good. From this year's trial it has nothing to recommend it over the varieties in general cultivation.

Gandy Belle. A very good plant producer and adapted to matted row culture. Berry very large, but inclined to be rough, flavor good. This year's trial shows it to be deserving of another year's testing.

Greenville (P). Foliage heavy and dark. It is a good plant producer. Stem medium in length; berry large to very large, round and pointed; color rather light. It is quite firm, flavor good. It is a promising berry.

Ivanhoe. Good plants and perfectly healthy. Berry medium in size, round and rather dark, yield poor. Not desirable.

Jay Gould. Stand of plants good; foliage attacked by leaf blight; foliage heavy and of a dark color. Berry large, round and slightly pointed, but the majority of them round, color light. Not very promising, as the yield was only fair and the berries were rather soft.

Mineola. It is only a fair producer. Plants adapted to hill culture. It only sets a light crop of fruit, berries large, round, and of a light color, rather soft. It is not desirable.

Princeton Chief (P). Stand very good, foliage attacked by leaf blight to some extent. Stem long; berry large, firm, round, and sometimes pointed. Color, dark. It is rather inclined to be rough when berries are large. Yield very good.

Paris King. A good stand of strong plants. Stem long, berry large to very large, round, and fairly firm, but the larger ones are rough. Color light, yield very good. It is a promising variety and deserves further trial.

Rio. It is an extra good plant producer. Foliage very slightly attacked by leaf blight; stem medium in length, berries large to very large; the largest ones inclined to coxcomb, rather light in color. Fairly firm and flavor very good.

Robinson. The stand good, some little leaf blight. Stem long, berries large, and some very large; round, some flat and rough; color, bright red; yield fair. It is deserving of further trial.

Splendid. Stand good, plants strong, and adapted to matted row culture. Berry large, firm, round and smooth, color bright red, flavor good, yield good. It is deserving of further trial. It is a very promising berry, excepting in yield, which may prove to be good on further trial.

Tennessee Prolific. It is a good plant producer, producing good, healthy plants. Foliage, rather dark color; perfectly healthy, stem long, and well filled. Berry large and inclined to be rough, rather long, large ones coxcombed, color light; firm and flavor very good.

Trimbell (P). A few plants and they are badly attacked by leaf blight. Berries large, but rough and ill shaped. It is not desirable, judging from this year's trial.

Barton's Eclipse. Foliage was damaged to some extent by leaf blight this year. It produced a good crop of large berries.

Bedar Wood. Plants healthy and it produced a good crop of small berries. The yield was not up to that of last year, and the berries were somewhat smaller. It is a safe variety to plant as it is a sure bearer and a good pöllen producer.

Eureka. A very heavy crop of large berries, the largest ones being rather rough. This berry deserves trial. It has always given good results on the Station grounds. Season with the Crescent, and it produces a heavy crop.

Enhance. This variety sustains the opinion we formed of it last year. It is promising for this section, and it will pay berry growers to test it on their own grounds.

Meek's Early. This variety has not proven equal to Michel's Early. It does not produce as heavy a crop.

Woolverton. Again produced a good crop this year. It promises to be one of the best varieties to use as a fertilizer.

The standard varieties, Michel's, Crescent and Gandy, along with Bubach and Haverland for fancy market, are too well known to need mention here.

The other varieties in the trial plots are not considered of sufficient value to be mentioned here. For a list of these the reader is referred to Bulletin No. 39.

NOTES ON THE ABILITY OF SOME OF THE NEW VARIETIES TO WITHSTAND THE DROUTH.

These were planted out in the Station grounds, March 21, and are practically in the same soil.

Marshall. Fifty per cent of a stand. The plants are good and strong, and it is a good plant producer. Foliage was attacked to some extent by leaf blight.

Glen Mary. Only 20 per cent of a stand, but the plants are fairly strong.

William Belt. Plants all dead.

Holland. Twenty per cent of a stand. Those living are healthy.

Clyde. A poor stand, 20 per cent only, and these are only fairly vigorous.

Giant. All dead.

Brunette. All dead.

Annie Laurie. All dead.

Eleanor. All dead but one plant.

Staples. It is a fair plant producer, but only 25 per cent of a stand.

Gardner. Ninety per cent stand, fine large plants, and a good plant producer.

Tubbs. A good stand, and it is a good plant producer; 85 per cent of a stand.

Bouncer. Good healthy plants; 65 per cent of a stand.

Sunrise. An extra plant producer, plants very vigorous; 75 per cent of a stand.

Sunnyside. Sixty per cent of a stand, and these are good and strong.

Lady Thompson. All dead but a few plants.

STRAWBERRIES AT THE BRANCH STATION AT CAMDEN.

The plants were set during the spring of 1895. The testing there has not been carried on for sufficient length of time to admit of drawing conclusions as to the varieties most desirable for that section.

The following tabulated notes are furnished by Mr. C. L. Newman:

Plot Number.	Variety.	Per Cent of Stand.	First Picking.	Last Picking.	Yield per 100 feet in Quarts.	Growth, Vigor of Plants—Scale 1 to 3.	Size of Berries—Scale 1 to 5.	Shape of Berries—Scale 1 to 3.	Blight—Scale 1 to 5.	Sun Scald—Scale 1 to 3.
1	Cyclone	100	April 30	May 21	13¼	2	2	3	1	
2	Arrow	100	April 30	May 17	23	3	4	2	1	
3	Columbia	100	April 30	May 15	6½	3	3	3	1	
4	Brandywine	90	April 30	May 17	11½	2	5	3	1	1
5	Timbrell	100	May 9	May 23	11	2	2	2	0	
6	Van Deman	100	May 2	May 4	1¼	1	4	3	1	
7	Dayton	100	April 25	May 6	9¼	3	4	3	0	
8	Bisel	90	April 30	May 5	5¾	1	3	2	1	
9	Banquet	80	April 30	May 17	4	1	3	3	2	1
10	Gillespie	70	May 2	May 11	1¾	3	4	3	1	
11	Belle	100	May 9	May 13	14½	2	2	1	3	3
12	E. P. Roe	90	May 6	May 15	18	3	3	2	2	
13	Woolverton	90	May 2	May 15	10¾	3	4	1	4	1
14	Barton's Eclipse	100	May 2	May 23	18½	3	4	3	3	1
15	Crawford	90	April 25	May 23	21¼	3	5	3	1	1
16	Bedar Wood	90	April 30	May 21	18¾	2	2	3	4	
17	Warfield No. 2	100	April 30	May 21	17½	3	3	3	1	
18	Hoffman	90	April 25	May 4	8¾	3	3	3	1	
19	Saunders	90	May 2	May 15	12½	3	3	1	3	1
20	Bubach No. 5	100	April 30	May 23	28¼	3	5	3	1	
21	Gandy	100	May 2	May 23	28½	3	4	3	2	
22	Splendid	100	May 4	May 23	20¾	3	2	2	4	1
23	Crescent	100	April 30	May 23	45½	3	4	2	2	
24	Michel's Early	100	April 23	May 17	16¼	3	4	3	3	
25	Enhance	90	April 25	May 21	25	3	4	3	1	
26	Edgar Queen	40	April 30	May 15	5¾	3	5	3	1	
27	Gov. Hoard	90	May 2	May 13	12¾	3	4	3	1	
28	Paris King	100	April 30	May 15	23¾	3	4	3	3	1
29	Enormous	100	April 30	May 21	34¼	3	5	1	1	
30	Ivanhoe	80	April 25	May 11	14¾	3	4	3	0	
31	Parker Earle	90	May 2	May 27	23¾	3	4	3	0	
32	Greenville	90	April 30	May 21	31½	3	5	3	1	
33	Sharpless	60	April 30	May 17	14	3	5	3	2	
34	Leader	20	April 30	May 13	2¼	2	3	3	1	
35	Gen. Putnam	90	April 30	May 15	15¾	3	4	3	2	
36	Jay Gould	100	May 2	May 17	25¼	3	4	3	2	
37	Lovet	100	May 2	May 15	17½	3	4	2	0	
38	Great Pacific	100	April 30	May 15	29½	3	5	3	1	
39	Meek's Early	90	April 18	May 4	7	3	3	3	0	
40	Belmont	90	April 30	May 21	17	3	4	2	0	
41	Haverland	100	May 2	May 21	23¼	3	4	3	1	
42	Wilson	0								
43	Muskingum	70	May 2	May 15	10½	3	4	2	0	
44	Mary	40	April 30	May 15	8½	3	5	3	3	
45	Mineola	90	April 30	May 17	9	3	4	2	4	
46	Gandy Belle	100	April 25	May 21	24	3	4	1	2	
47	Mrs. Cleveland	100	April 30	May 21	31¼	3	5	3	0	
48	Robinson	100	April 23	May 15	30¾	3	5	3	1	
49	Tenn. Prolific	100	April 23	May 17	31¼	3	5	2	1	
50	Princess	100	April 23	May 21	42	3	5	3	0	1
51	Chairs	100	April 30	May 17	24	3	4	3	0	2
52	Beverly	90	May 2	May 23	24¾	3	3	3	1	0
53	Princeton Chief	100	May 2	May 23	20¾	3	3	2	5	3
54	Klickitia	80	May 6	May 21	4½	2	2	3	2	
55	Swindle	100	May 2	May 23	20¾	3	3	2	4	3
56	Sandoval	80	April 30	May 15	15	3	5	3	1	
57	Stayman No. 1	100	May 2	May 23	34	3	4	2	1	1
58	Rio	100	April 23	May 13	15¾	3	5	3	1	
59	Shuster's Gem	80	April 25	May 17	12¾	3	4	3	1	

Between April 13 and September 25 only 6.77 inches of rain fell. By the middle of July not 200 plants in he whole lot were alive. By August 15 there were practically none alive, notwithstanding that shallow ultivation was given once or twice per month up to July 15.

STRAWBERRIES AT PINE BLUFF.

Report of Mr. William T. Simpson, of Pine Bluff, on varieties that he has been testing for the Station at that place. His notes are given in full:

Bubach (P). The most satisfactory berry on my place with the exception of one or two of the newer introductions, and they will have to be tested further before I would be willing to discard the Bubach. Plant very robust and healthy. Berries are not the best, but of good quality, large size and plenty of them.

May King (S). Extra early to very late, of handsome berries of the best quality; it is not a heavy bearer at any season, but it is with the earliest, and berries can be picked from it after the Gandy is gone. I find it an excellent fertilizer for Bubach and Haverland.

Haverland (P). Early berry, productive of large, long berries of good quality, too soft for shipment, but an excellent berry for home use or near market.

Bedar Wood (S). Nearly as early as Michel and very prolific, but berries are of a very poor quality, soft and small with the exception of the very first berries. Foliage subject to rust.

Tennessee Prolific (S). Medium early, not satisfactory here; it blooms profusely and sets heavily with fruit, but fails to perfect its fruit with the exception of a light crop.

Cumberland (S). Medium early, fine shape, good quality, not very productive, but the berries are nearly all medium to very large, a good berry with high culture.

Gandy (S). Medium to late, of large berries, good shape, solid, good quality, but a shy bearer under ordinary culture, but with hill culture it is a profitable berry for market. Plants very healthy.

Greenville (P). Medium early, very prolific; berries are good shape, large at first, smaller later, rather soft. Berries are borne near the crown and lying on the ground, as they do, a good many are damaged on one side before they are ripe. Plants are healthy but rather small.

Gandy Belle (S). Early, good shaped berry, splendid quality, medium to large size and prolific, foliage healthy. It makes a fair crop of late berries nearly equal to a whole crop of Gandy with ordinary culture.

Taking everything into consideration I consider it one of the most satisfactory berries for market.

Holland (P). Medium to very late, good size, perfect shape, excellent quality, some rust on foliage; like the Gandy Belle it bears a fair crop of very late berries after the Gandy is gone, and a crop almost equal to Gandy after yielding a good crop of medium early. Berries are firm and would make a good shipper.

Mary (P). One of the largest berries, perfect shape, healthy plant, but not productive enough with me for general planting.

H. W. Beecher (S). Ideal foliage, but of no value for berries here. A few very large berries are found, but a great many plants never have a berry on them.

Timbrell (S). Not satisfactory here at all, berries small to medium, rather late, poorly colored, quality of the best.

The following varieties were set this spring, and nearly every plant lived, and made a splendid growth until the drouth set in; very soon some of the varieties began to die out, while other varieties hung on to life with surprising tenacity. The drouth resisting quality of a strawberry is such an important quality that I think it will be of interest to give the per cent of each variety that is left alive after the most severe drouth ever known here. All of the plants in this plot have exactly the same chance every way, and had perfectly clean culture all through the season. There are several old varieties of the plot whose drouth resisting qualities are well known, which will be of help in determining the good qualities of several of the latest introductions. The soil is a sandy loam of good fertility. Most of the blooms are kept picked off. Each variety was allowed to bear a few berries, but I deem it unfair to report on the bearing qualities of any of them. At the same time I cannot refrain from speaking a good word for a few of them in a general way. Brandywine is a magnificent berry and the foliage is perfect. Tubbs stood the drouth best of all, and is one of the most promising berries on the plot. William Belt comes next. Only a very few plants of either of the two last named died during all the drouth, while the Eleanor, just at their side, all died early in the season. These two berries I certainly regard as acquisitions. For the honors among them is Princeton Chief, Columbia, Shuster's Gem, Brunette, Splendid, Meek's Early, Parker Earle and Clyde. The per cent of each alive, September 15, is given. I thought it best to put each variety down exactly as it stands in the plot so as to show that it was not a difference in soil that caused such difference in vitality.

Meek's Early (S)	90	Enormous (P)	30	Edgar Queen (P)	35
Annie Laurie (S)	5	Brandywine (S)	3	Enhance (S)	5
Columbian (S)	70	Shuster's Gem (P)	60	Woolverton (S)	50
Glen Mary, all dead.		Sunnyside (S)	15	Princeton Chief (S)	85
Princess (P)	5	Parker Earle (S)	85	Robinson (S)	40
Bisel (P)	3	Cyclone (S)	60	Splendid (S)	70
Tubbs (S)	98	William Belt (S)	95	Clyde (S)	45
Sunrise (P)	4	Warfield (P)	25	Rio (S)	50
Barton's Eclipse (P)	5	Eleanor, all dead.		Brunette (S)	45
Bubach (P)	30	May King (S)	35	Bedar Wood, all dead.	
Gandy Belle (S)	10	Greenville (P)	5	Holland (P)	3
Marshall (S)	92	Mary (P)	4	H. W. Beecher (S)	10

STRAWBERRY REPORTS.

For the purpose of obtaining some information direct from the growers of strawberries from the several strawberry sections of the State, a circular letter was sent out soon after the close of the season. The letter asked for the opinions of the growers as to the best varieties for shipping, home use and home market. Some information was also desired regarding the varieties that give the best results as pollenizers, and as to methods of culture and planting generally practiced, and kinds of manures and fertilizers generally used. These reports are given in full in most cases; some were too long to give fully; they are very valuable to those contemplating planting, and coming as they do from the leading growers of the State there is much of value to all growers of strawberries.

D. Wing & Bro., Rogers, Benton County. Varieties generally grown are three. Most satisfactory varieties are Michel, Crescent and Gandy. Most productive and all purpose variety, Crescent. Best for home use, Michel. Best for shipping, Crescent. Staminate varieties giving best results as fertilizers, Early Michel and Downing. Three rows of pistillates are generally grown to one of staminate. Growers do not practice hill culture. Two hundred acres cultivated here. Yield averages 50 crates per acre. Very little insect injury and no leaf blight.

George M. Irvin, *Dyer*, *Crawford County*. The number of varieties most generally grown are three, Michel, Crescent and Downing. Crescent is most productive and best for shipment. Michel is considered our best all purpose berry and the best for home use; also the best one for a fertilizer. While it is not satisfactory as a fertilizer for late berries it is the best one to plant with the Crescent. One row as a fertilizer is generally grown to four pistillates. The number of acres cultivated around this point are 500 and the average is about 50 crates per acre.

The ground is bedded in February and March in 5-foot rows or beds, in some instances the beds are harrowed off before planting. They are then opened about 3 or 4 inches and the plants are set in the furrow about 2 feet apart; they are set by hand. The first plowing is given soon after setting, and the cultivation is continued for several months and is somewhat similar to that given cotton. Our methods of renewing old beds are to cross-plow the old rows, while some prefer to plow up the old beds leaving the plants either to the left or right of the old row. Others plow up the old bed entirely, leaving only the new plants between the rows for the next year's crop.

No manuring or fertilizing is done to any extent.

M. F. Winn, *Van Buren*, *Crawford County*. The number of varieties generally grown here are two, Michel and Crescent. The most productive variety is Crescent, and we consider it the best for home use. The best all purpose berry and the best one for shipping is Michel, while Downing gives the best results as a fertilizer. The number of rows of pistillate generally grown to one of staminate are, when Downing is used, four to one, and when Michel is used, one to one. Hill culture has not proven satisfactory here. The number of acres cultivated around this shipping point are 2,500, and the average yield is from 50 to 100 crates per acre.

In regard to setting out and after cultivation of the plants: The plants are usually set in February or March. Two methods are practiced in preparing the land. The one most followed is to break and harrow the land, and make beds about 3½ feet apart. Open these with a small plow, and set the plants in the furrow. The other is to break and harrow the land, and open furrows about 3½ feet apart. The plants are set in the furrow about on a level with the surface. Five thousand plants are usually set to the acre. Cultivation begins soon after planting. In cultivating we use small plows (calf tongues), on double-shovel stocks, for the first two or three plowings, then we use 6 inch blades. The fields are cultivated every ten days where it can be done. Our method of treating old beds is to plow through the middle three or four times, and let them go until the next season; doing this for about three years, then we plow up and set. We have tried no fertilizers, except stable manure. That increased the crop about 50 per cent.

E. G Arkebauer, *Van Buren*, *Crawford County*. The most satisfactory berries with me are Michel, Bears and Gandy. Best variety for shipping is Smeltzer's Seedling. The varieties giving the best results as fertilizers are Michel for early and Gandy for late. The number of rows of pistillates generally grown to one of staminate are three. The average yield in crates per acre is about 75.

Early in spring the soil should be thoroughly prepared, then throw up a low bed with the plow as for cotton; this dragged down until nearly level, when it is opened with a small shovel, and the plants are set on the furrow. The roots should be spread so that they will come in contact with the soil. The furrow should be filled even with the top of the ground. If the plants are set in rows both ways, so that they can be worked across the rows until plants have started runners, it will save most of the hoeing.

As soon after picking as possible a plow should be run around each row, leaving only about 6 inches of the center. The ridge left is then harrowed. Cultivation should begin immediately, and the soil worked back towards the plants. The cultivation should be thorough, and be continued during the season. The plants will soon make new runners for young plants, which should not be disturbed, as the first new runners make the best berry plants. As to fertilizers, I find nothing better than barnyard manure applied in winter.

S. J. Mathews, *Monticello*, *Drew County*. The number of varieties generally grown are from three to five. The most satisfactory varieties are for early, Michel; for medium, Bubach, Haverland and Wilson; and for late, Gandy. I consider the Bubach as the best all purpose variety. It is the most productive, and is the best for home use. Those best for shipping are Michel and Wilson. There are no large areas cultivated around here.

The location of a strawberry field is very important. Low land is best, provided the drainage is good; next to that a hillside having a northeast exposure. Land should be broken as deeply as can be done by subsoiling, and made rich and in fine tilth. Cotton seed, or cotton seed meal and hard wood ashes are valuable. Barnyard manure may be used, provided it is well rotted, but it is objectionable on account of the weed seeds that it is likely to contain.

Planting should be done from February to April. I have had the best success setting plants when they were in bloom, but blooms should be clipped off at transplanting, and kept off during the first season. Soil should be kept clean and well stirred. The runners should be kept off of the original plants until they are well established, when they may be allowed to grow and form a matted row. With plenty of good plants of one's own raising, better plow up the old beds, after gathering second season, and plant land in cow peas, and at the last working sow crimson clover to be plowed under as a preparation for another planting of strawberries. It is advisable to plant a new field every season.

George P. Murrell, Austin, Lonoke County. The most satisfactory varieties here are for early, Michel; for medium, Crescent; for late, Bubach and Cumberland. The most productive and all purpose variety is Crescent. The best for home use is Bubach, and those best for shipping are Crescent and Michel. The staminate varieties giving the best results as fertilizers are Michel, Wilson and Sucker State, and they are usually planted one to four. The number of acres planted around Austin are about 200. The average yield in crates per acre is 75.

The ground is usually broken with two horses, thoroughly harrowed and laid off with a bull-tongue plow, rows 3½ feet apart, and shovel plow run on each side of the row, so as to make a small ridge which is usually harrowed down bringing it to the level of the balance of the land, but leaving drainage on each side. Plants are usually set by hand or with a dibble 18 inches apart in the row. Bone meal or pure ground bone we consider the best fertilizer for strawberries, which is usually applied at the rate of a ton to 6 acres in the bottom of the first furrow and the ridge made upon it. The usual mode of cultivation is to run a one-horse cultivator around the plants which is sufficiently broad that one round will clean the middle, and as weeds and grass come in the rows they are hoed out. Sometimes we find it profitable to run a small plow in the middle, especially after hard beating rains in order to stir the ground deeper.

The renewal of old plantations is about a thing of the past with us as we find it more profitable to have young plantations coming on to take the place of the old ones after the third crop.

The excessive heat and dry weather during the past summer has about made a wreck of our strawberry plantations, especially those that were set out in the spring. The older plantations stood the drouth much better than young ones. Our acreage has been cut off by the dry weather 50 to 60 per cent.

W. K. Tipton, *Little Rock*. The most satisfactory varieties are for early, Meek's Early and Michel; for medium, Lady Thompson, Greenville and Crescent; and for late, Gandy. The most productive varieties are Greenville, Crescent and Warfield. Best for home use are Michel's, Lady Thompson and Gandy. The best staminate varieties for fertilizer, are Lady Thompson, Bedar Wood, Enhance and Miners' Prolific. There are usually not more than three rows of pistillates grown to one row of staminate.

Will L. Harding, *Little Rock*. The most satisfactory varieties for early are Meek's and Michel's; for medium, Bubach, Jumbo and Crescent; for late, Enhance, Gandy and Brandywine. The most productive variety and best for home use is Cumberland. Best for shipping are for early, Michel's; for late, Gandy. The staminate varieties giving the best results as fertilizers are Michel and Jumbo. The number of rows of pistillates generally grown to one of staminate are four. The growers do not practice hill culture. There are 150 acres in cultivation around Little Rock and the average yield is about 60 crates per acre.

The varieties that are grown here and that seem best suited to this portion of the State are Michel's Early, Crescent, Cumberland, Gandy and

Bubach No. 5. Others worthy of extended trial and grown here for market to some extent, are Meek's Early, West Lawn, Paris King, Gillespie, Lady Thompson, Barton's Eclipse, Shuster's Gem and Princess, named in their order of ripening. Of new late varieties that promise well, have tried Brandywine, Michigan, Yale, Enhance and Mexican Everbearing. The greatest drouth resisting varieties that I am acquainted with are Crystal City, Numan and Benton Scarlet.

The soil best suited is new land cultivated in some other crop one season previous to planting strawberries. If old land that is worn is used put on eight or ten good two-horse loads of stable manure per acre. Cotton seed meal is valuable. The manure is by far the most lasting and should be put on before planting. If using the meal I would put on one-half after plants are set and one-half in February of the fruiting year by sprinkling among plants. Sandy soil will produce the brightest and firmest berries. Heavy dark soil produces the reverse but stands drouth better.

Prepare the land by plowing deep. Plants are set either in spring or fall in 4 feet rows 18 inches apart. Cultivate and hoe shallow, but often. In renewing old beds bar off with turning plow and cut to a stand, then dirt up with a bull-tongue, and break up the middles thoroughly afterwards; cultivating shallow as with new beds, to be done as soon after the fruiting season as possible. Most of us use crabgrass as a mulching material by letting it grow late in the season. Clean culture with straw manure or cotton seed hulls is best, however, for large yields and uniform size of fruit.

J. B. Little, *Huntington*, *Sebastian County*. The most satisfactory varieties are Michel's Early, Crescent, Captain Jack, Charles Downing and Gandy. The most productive variety is Crescent, best one for home use Cumberland. Varieties giving best results as pollenizers are Michel's, Captain Jack and Charles Downing.

J. C. Bauer & Sons, *Judsonia*, *White County*. The most satisfactory varieties for early are Michel's Early, Hoffman and Tennessee; and for medium; Bismarck and Tennessee, and for late, Bismarck, Aroma, Gandy and Tennessee. Best general purpose variety, Tennessee Prolific. The varieties giving the best results as pollenizers are

Michel's, Gandy, Tennessee, Bismarck, Lovett, Aroma and Sandoval. There are about 600 acres in strawberries around this place. The yield is about 50 crates per acre.

Strawberries do best here on new land. Plant in rows 4 feet apart and the plants 3 feet apart in the row; after the plants start to grow only cultivate one way. They generally make a densely matted row by fall. Plow the land deep in preparing to set out plants and put it in good condition. After the plants are set plow shallow and often. The top crust should be broken after every rain. If the soil should be too loose around the plants a roller can be used to good advantage to firm the soil; there is no danger of injuring the plants.

In renewing old beds we take a one-horse turning plow and bar off the rows, leaving them from 6 to 10 inches wide, then clean out with a hoe. The plants are left from 12 to 14 inches apart in the row. In cutting out the plants care should be taken to chop out the old plants leaving only plants of the previous season's growth. The beds are then cultivated the same as those set in the spring.

The best fertilizer for strawberries is pure bone meal applied around and among the plants in the fall before the last workings, 200 to 400 pounds to the acre, and apply potash in the form of wood ashes up to fifty bushels per acre, or muriate of potash at the rate of 100 pounds per acre at any and all times when convenient. Good stable manure applied after frost broadcast over the rows and left for the fall and winter rains to leach it into the soil will work wonders, but I prefer the bone meal.

VARIETIES PREFERRED HERE BY US FOR MARKET AND HOME USE.

Aroma. This takes the place of Gandy with us on account of its productiveness, large size, beauty and flavor. This is the only variety we have ever seen that the young plants do not all bloom about the same time, but they extend over a period of two or three weeks, thereby prolonging their season of ripening that much. Season of ripening a week or ten days before Gandy and lasts longer. It is a vigorous grower; staminate.

Bismarck. This is the third berry we have originated and introduced; it is a cross of Bubach No. 5 and Van Deman; perfect bloomer, productive and a good shipper, fine flavor and a very large berry.

Tennessee Prolific. This takes the place of Crescent. It is certainly an acquisition for strawberry growers. Fruit large, very productive and extends over a season of three weeks. We recommend this for the family garden as it will produce berries when others fail.

Mexican. It is a large, healthy, dark green plant. Fruit very large, flavor exquisite, perfect shape and firm. It needs the very richest soil for best results.

R. J. Winn, Judsonia, White County. The most satisfactory varieties are Michel's Early, Crescent, Barton's Eclipse, McNeil, Tennessee Prolific, Haverland and Gandy. The most productive varieties are Crescent, Barton's Eclipse and McNeil. The staminate varieties giving the best results as pollenizers are Michel's Early, Arkansas Traveler and Tennessee Prolific. The number of rows of pistillate varieties grown to the staminates are four to two. The number of acres cultivated around this shipping point are from 300 to 500. The average yield in crates is probably 50.

The land is first well plowed then marked with a single shovel plow, and bedded over the furrow thus made with a turning plow or a single shovel. It is then checked 3 feet, the rows being 4 feet apart, and the plants are set at the intersection. We cultivate both ways until July, when cross-plowing is stopped and cultivation is given only one way. The matted row is allowed to form. In one sense we do not renew old beds, in another we do. We generally take from three to five crops from a field before plowing under. In cultivating old beds (that is after first crop) we set a furrow with a single shovel plow, then bar off the rows, cutting out the plants to a stand with a hoe. After allowing to stand a few days we then throw the soil to the plants and plow out the middles with double-shovels. Plants left thus in the row throw out runners and form a matted row of mostly new plants by fall. Through the summer the plants are hoed some, but most of the work is done with five-tooth cultivators and double-shovel plows leaving the rows bedded out in the fall.

Very little manure is used here. Bone meal where tried has given good results. Barnyard manure gives the best results. In my report as to number of crates per acre the average is rather low, owing to the fact that there are many growers who do not cultivate and fertilize their fields to get heavy yields. Regarding some of the varieties grown here the Barton's Eclipse should not be set on flat land at all; it blights but little on rolling sandy land.

The Tennessee Prolific is new with us, but it bids fair to be quite an acquisition. It is quite productive for a staminate. This season has been a very dry one here. I worked out my plants right away after picking and have kept them well cultivated all season and they are fine.

B. Rudolph, Fayetteville, Washington County. The most satisfactory varieties are for early, Michel's; for medium, Crescent and Downing; for late, Bubach, Haverland and Enhance. Best all purpose berry is Crescent. Staminate varieties giving the best results as pollenizers are Michel's, Downing, Enhance and Woolverton.

In preparing to plant strawberries the land should be plowed deep and put in fine tilth. Mark one way with a marker 3 feet between rows, mark the other way with a single plow, rows 3½ feet apart. Set two plants in the check slightly above the level of the ground, cultivate both ways until the runners get 18 inches long, then only cultivate the wide way. Keep them free from all weeds until August 15. Do not cut any runners off. Leave the ground slightly ridged at last plowing. We give the fields about twelve plowings and seven hoeings during the season. To cultivate old beds we plow as soon as through picking; ought to be plowed four or five times. Well rotted stable manure gives good results as a fertilizer. Red clover is valuable in preparing ground for strawberries. Regarding the setting of plants, plants should be set on the side of a furrow, roots straight down and spread out. Use hoe to pull the soil to the plant and to firm the soil about the plants after they are set.

R. E. Lynch, Humphrey, Arkansas County. The most satisfactory varieties for early are Hoffman, Michel's Early and Meek's Early; medium Van Deman, Haverland, Bubach No. 5 and Barton's Eclipse; for late, Gandy's Prize, Parker Earle and Woolverton. The most productive varieties are Crescent (Boynton) and Haverland; best all purpose berry Hoffman; best for home use, Sucker State, and the best for shipping are Hoffman, Meek's Early and Cloud. The staminate varieties giving best results as fertilizers are Hoffman, Van Deman and Woolverton. The number of rows of pistillates generally grown to one of staminate are two. One grower here practices hill culture. There are about 20 acres in cultivation here and their average yield is about 75 crates. Considerable insect injury and some varieties are troubled with leaf blight.

Usually nothing is done towards renewing old beds until the crop is gathered, by which time they are generally pretty foul. First I use a small one-horse plow to bar them off deep, thus plowing up and turning under all grass and weeds. I then use an ordinary single cotton scraper to trim the plants down to 4 to 6 inches wide in the drill, then run a 6-inch shovel in the scraper furrow as deep as possible. This loosens up the ground around the plants, and throws sufficient dirt to the drill to prevent evaporation. Let them stand (hoe if necessary) until vegetation in middles has rotted sufficiently, then pulverize the ground with cultivator or harrow. Plow out middle deep with turning plow. From then on cultivate frequently (as near level as possible) until frost, leaving good water furrow last plowing. Hoe drill when necessary to keep down grass and weeds. Stable manure, wood ashes, bone meal and dissolved bone are used as fertilizers. The varieties must be studied to be able to fertilize intelligently. Stable manure adds to plant growth and should be applied in October and February. Ashes add firmness and color to the berry and should be applied in February. When stable manure and ashes cannot be had bone meal and dissolved bone can be used. I think best results are obtained by applying 200 pounds bone meal per acre on drill in October and 200 pounds in February or 200 pounds dissolved bone in February.

SMALL FRUITS.

The growing of strawberries, blackberries and raspberries in this State for Northern markets is demanding considerable attention. The crops ripen at a time when they usually command a good price. The location and soils of certain sections are admirably fitted to small fruit culture for those markets and the berry areas are increasing each year. Strawberry growing has been extensively and successfully carried on in some sections for several years; around some shipping points the acreage is very large.

Blackberries and raspberries as well as strawberries are being more extensively grown each year, the early blackberries are more generally grown for market, and the Early Harvest variety is the leading variety for long distance shipments. It is for the purpose of giving some general information on the culture of these fruits that a few notes are given. They are intended for those who contemplate planting and are at a loss to know just how to proceed. The general advice to all such is to start in the business rather slowly by planting small areas at first; and increase the plantings as experience and knowledge of the business will justify.

LOCATION.

There is not much danger of late frosts injuring the crop in this State as in less favored localities, but it is important in selecting a location, to secure one that is out of the danger line if possible. Flat low lands should be avoided where practicable, and elevated situations, where the valleys or ravines take the cold air are desirable. All are familiar with this fact particularly those who have traveled in a rough country after night when considerable difference in the temperature of the valleys and hills is noticed. The cold air is drained from the elevated portions to the valleys. The limits of first frosts are very noticeable on the sides of hills and mountains.

SOIL.

A good rich soil is always desirable. Small fruits demand an abundance of plant food, and the selection of a good soil to begin with insures greater returns; it should be deep to hold sufficient moisture for the plants during a dry period, and if not naturally well drained it should be tile drained to get rid of the surplus of moisture. Tile draining will pay on most soils that are to be planted in small fruits.

As a rule use the best soil on the farm for small fruits, and put it in the best possible condition. Rich loam gives the best results as a rule, but sometimes, as with some varieties of strawberries, a more retentive soil gives better results. Sandy soils are to be avoided for strawberries, unless it is practicable to mulch them to protect the fruit from the sand. A soil that will produce a good crop of Irish potatoes will give good returns in small fruits; there is not much danger of getting it too rich. For early berries a southern exposure and soil with some sand gives best results, while for the main crop a larger one is obtained from a heavier soil. There is some difference in the requirements of varieties of strawberries; Michel and Crescent will do best on a lighter soil than will Bubach, Haverland and similar berries. These points will soon be ascertained by the grower who is studying his business.

PREPARATION OF THE SOIL.

The preparation of the soil for a small fruit crop is of much more importance than the preparation for an ordinary field crop, which is to occupy the land but for one year. The plants of the small fruits remain in the soil and bear crops for from two to several years. The preparation should begin at least one year before planting, and two years' preparation is better.

The growing of such crops as admit of clean culture—corn, potatoes and similar crops—is of great advantage in putting the soil in good tilth and freeing it of weed seed, and where sod has been plowed under, to free it of insects, such as the white grub, etc. Where berries follow sod there should be two years intervening, with clean culture crops. Irish potatoes give excellent results when used to prepare soil that has been heavily manured with barnyard manure for berries.

Barnyard manure is commonly used in preparing berry land. It furnishes the desired plant food, besides furnishing the vegetable matter, which is so essential to most of the soils of the State. Vegetable matter in the soil is an important item, and must be considered in preparing the land. It furnishes to the plant nitrogen, the most expensive of all the ingredients of the plant food; it furnishes phosphates in an available form; also potash, and assists in holding moisture in the soil.

Vegetable matter may be added to the soil by the use of leguminous crops, such as cow peas and the clovers (Red and Crimson), by this means the supply of nitrogen is kept up, and much plant food is added besides. The use of the phosphates and potash in addition to the nitrogen producing plants gives the best results.

The use of fertilizers that furnish phosphates and potash with the leguminous crops have the advantage over the stable manure that they are free from weed seeds. Where stable manure is to be used it should be well rotted and worked over to kill all weed seeds.

Cotton seed meal is used to some extent with good results; it is generally applied when the plants are set.

PLANTING STRAWBERRIES.

Spring planting is generally practiced by the growers and gives better results in all cases, planting after the crop is gathered in. June gives good results in some cases, but cannot be relied upon. When planting small areas it is often advisable to plant in August and later when the fall rains set in, as a light crop can be secured the following season.

Always set good plants from new beds; old plants are practically worthless. There are nearly as many methods of setting as there are growers. The plants are commonly set in rows about 3½ feet apart and from 18 inches to 3 feet in the row. Where cultivation both ways is given 3 feet apart in the row is a good distance. When the plants are set the main point is to have the roots all come in contact with the soil. Whether they be set with a dibble, by hand or with a hoe the roots should be spread out so that they all come directly in contact with the soil, as it insures a larger per cent living, and enables the plants to reach the plant food more readily, therefore a stronger growth. In the large strawberry fields rows are run with a bull tongue plow, the field being previously marked crosswise with an ordinary corn marker, and the plants are set at the intersections either by hand or with a hoe.

The methods of cultivation of strawberries have been given by growers in the different sections and the general points of each agree. All agree that the soil should be thoroughly prepared by deep plowing and that very thorough cultivation should be given.

BLACKBERRIES.

This crop is of considerable importance in some sections of the western part of the State as a market crop for Northern markets.

The early varieties are more generally grown, but good results have been obtained from the late varieties as well.

The geographical location of the State is such that the growing of small fruits is profitable. They go into the Northern markets when the prices are generally good. The blackberry is equally well adapted for this purpose with the other small fruits. The crop is practically a sure one, and one that is likely to bring good returns each year for the labor expended.

The land should be a good clay loam, one that will retain moisture and having sufficient vegetable matter not to bake after rains. Wet land should always be avoided. The soil should be well prepared by a deep plowing, being previously heavily manured. The distance apart of the rows should be 6 feet at least, and for some varieties 8 feet apart is perhaps better. The plants are usually set from 4 to 6 feet apart in a row. This distance enables one to cultivate both ways. Setting is usually done in the spring, one year old plants being used. None but strong and healthy plants should be used, and if they are purchased it should be only from reliable parties. The plants may be obtained from the suckers that grow up from the roots or from root cuttings.

Root cuttings are made by using the roots that range from ¼ to ½ inch in diameter. These are cut about 2 inches long and put in the cellar or out in the ground to callous. They are made in the fall, and are calloused and are ready for growing by spring.

The planting is usually done about corn planting time. The cuttings are planted in rows so that they may be thoroughly cultivated during the season. They are ready for setting in the field the following spring.

Plants should be set deep because they will stand drouth better and are more liable to secure a strong root system; they are usually set from 4 to 6 inches deep. The tops are cut off near the ground. When the plants are set only four or five canes should be permitted to grow the first season, and not more than six or seven allowed to grow subsequent seasons, if the best results are to be obtained.

Cultivation should begin immediately after setting and be continued through the season and should be frequent. Every rain should be followed by a shallow cultivation, and not more than a week should intervene between the stirrings of the top soil.

The object in the cultivation after every rain, and the frequent stirring of the top soil, is to hold the much needed moisture in the soil for the use of the plant in producing and maturing a good crop of fruit. Weeds are all kept down by this frequent cultivation, and the plants are much freer from disease than those not cultivated. Most careful berry growers are well aware of the effect of thorough cultivation and do not slight this important part of the successful culture of berries. By the careful use of the cultivator very little hoeing need be done in the berry fields, and much time can thus be saved. Thorough cultivation has long been recognized as the best means of putting the soil in a fertile condition, and supplying plant food to the growing crops. There are a number of good tools manufactured by the different implement houses for this purpose. A Planet Junior cultivator is a good tool, and a similar tool may be obtained from other companies. There are spring tooth cultivators that give good results in the berry fields.

Training. The canes that grow from the root one year bear fruit the following year, but do not bear again, and after bearing they may be cut out at any time. This is generally done the following spring, although it may be done advantageously as soon as the crop is harvested, and should be removed before growth begins in the spring. About six or seven canes should be allowed to grow each year to bear the fruit the following year. The strongest ones are chosen and the others pulled out and kept out. The canes that are chosen for the bearing canes for the next year should be headed in by cutting off a few inches of the tip when they are 2½ to 3 feet in height. This causes the latterals to grow more vigorously near the ground, and gives a well balanced top. The latterals are usually shortened in the following spring and it is necessary in doing this to have some knowledge of the fruiting habits of the varieties, as some bear their fruit near the main stem, while others bear near the ends of the latterals.

Blackberries are sometimes trained to wires the same as grape vines. A two-wire trellis is generally used. The growing canes are so tied that they do not interfere with those in bearing. The following spring they are tied to both wires which support them during the bearing season.

RASPBERRIES.

The preparation of the soil and the planting of the raspberries, as well as the after treatment, is practically the same as for the blackberry.

The black raspberry, however, is increased by means of the tips rooting. The red raspberry is increased by suckers that grow from the roots, but both may be increased by root cuttings, the same as the blackberry. To enable the tip of the black raspberry to take root readily the soil should be kept in excellent condition. After the tips become rooted the stems may be cut off, and the plants are ready for setting the following spring. The raspberries should be set deep the same as the blackberry. A good plan is to run the furrows rather deep and set the plants and fill in as they grow.

The black caps should be pruned during the summer. The canes are usually cut when they reach the desired height which is somewhat lower than the blackberry, as the latterals do not grow vigorously near the ground if the tops are allowed to grow to any considerable height.

The varieties of blackberries generally giving best results in this State are Brunton's Early, Early Harvest, Lawton and Snyder.

The raspberries (red), Shaffer, Cuthbert, Marlboro and Turner. The black caps are Gregg, Ohio, and Souhegan

**Mammoth Cluster.* Black, large size, productive; resembles Gregg, but not so much bloom and a few days earlier.

Gregg. Black, large size, very productive, covered with heavy bloom, medium to late in ripening. Size holds up pretty well to end of the season.

Kansas. Black, largest size, very productive, heavy robust growth. Best black cap at this place.

Souhegan. Extra early, black cap, small to medium in size, running small at end of season. Drouth affects them more than any other.

Palmer. Extra early black, good size and holds its size well to end. Very productive and the quality is first rate. A very satisfactory black cap.

Shaffer's Colossal. Purple berry, season early to late, large size. Canes scalded considerable last year, but have gone through the past drouth and seem healthy this season.

Cuthbert. Red berry, late in ripening, best quality, large to medium in size. Canes healthy both in cold and heat; not so productive as some others, but a satisfactory berry for market or home use.

---

*Notes from Wm. T. Simpson, Pine Bluff.

Miller. Red berry, largest size, solid, early. Not so sprightly in taste as Cuthbert, but more productive and very much larger, and holds its size to the end of season. Healthy cane, not so tall as Cuthbert.

Royal Church. Red berry, large size, rather soft, medium early, very productive. Holds its size well to end of season.

Marlboro. Red berry, good size, medium early, fine color. Has been winter killed to the ground with me for several years; not satisfactory on this account only.

Golden Queen. About same as Cuthbert, except in color.

Columbia. Purple berry, medium early to very late, of very robust growth, enormously productive. Berries of largest size and splendid flavor.

GRAPES.

The varieties growing on the Station trial grounds were described in Bulletin No. 39 from this Station. Many of them are of little or no value here; others are some little value and may do well in some sections. The number of varieties for general planting in this State is small. A number of new varieties were set in the trial vineyard last spring. Most of these are productions of T. V. Munson, Denison, Tex. He has done much valuable work in producing new varieties suited to the southern section of the country. There are probably some of these varieties that will be of value here.

There was considerable difference in the drouth resisting qualities of the different varieties this season, and notes were taken regarding this difference and, when similar notes have been collected for a sufficient length of time to admit of conclusions the whole will be published.

Grapes do well in most sections of this State, but owing to the great difference in climate and soil all varieties that do well in one section do not give good results in other sections. This is shown by certain varieties succeeding here and are failures on the trial grounds at Pine Bluff. It takes considerable time to test a variety for any given section, and then the results can be depended upon only for that immediate section, although in a general way those varieties doing extra well in a few sections may be safely planted in others. There are certain standard varieties, but it is always best in selecting varieties to be guided by those that do best in the particular section where the planting is to be done.

The notes on the different varieties of grapes are not given as conclusive for any variety, but are offered merely as aids in determining what varieties to plant. Reference is made to Bulletin No. 39 for the quality and the class to which a variety belongs.

The Station vineyard bore a heavy crop this year. It was sprayed three times with Bordeaux mixture to prevent black rot and other fungous diseases; but the unsprayed fruit this season was exceptionally free from diseases. The extreme drouth checked all diseases.

The crop suffered severely from the drouth, some varieties much worse than others; those bearing very heavy crops suffered most. The vineyard was given good cultivation; the surface soil was kept loose to assist in holding the moisture. The effect of the drouth on vineyards not cultivated was more disastrous and a good opportunity was thus afforded to compare the condition of cultivated vineyards with those given little or no cultivation. Aside from the effect on the fruit the good effect of the thorough cultivation will be shown in next year's crop. In the uncultivated vineyards many vines died and practically no fruit was properly ripened.

The importance of clean culture for vineyards cannot be too strongly urged. Frequent and shallow cultivation holds the moisture in the soil for the use of the vines while maturing the fruit.

The varieties fruiting here and at Pine Bluff will be given a general classification into good, fair and undesirable. This is based on the recorded observation of the varieties fruiting at these places. Further testing, however, may give different results.

The varieties doing best here and those likely to succeed over a large portion of this section of the State are classed as good. They are Berckman's Brilliant, Concord, Cottage, Cynthiana, Delaware, Early Ohio, Elvira, Green Mountain, Hartford, Herbemont, Herman Jaeger, Janesville, Moore's Early, Moore's Diamond, Norton's Virginia, Worden and Wyoming Red.

The varieties that have generally given satisfaction, and are classed as fair, are Agawam, Amber, Amber Queen, Aminia, Arkansaw, August Giant, Barry, Black Pearl, Black Eagle, Cambridge, Champion, Catawba, Cunningham, Diana, Dracut Amber, Dutchess, Early Golden, Eaton, Etta, Goethe, Herbert, Hermann, Iona, Ives, Jefferson, Lady Washington, Lindley, Missouri Riesling, Montefiore, Noah, Norfolk, Perkins, Rentz, Rommel, Telegraph, Wilder and Woodruff.

Those considered undesirable for planting in this section are Amanda, Bacchus, Centennial, Clinton, Conqueror, Creveling, Devereux, Faith, Golden Gem, Grein's Golden, Highland, Ironclad, Isabella, Israella, Lady, Martha, Mary Ann, Maxatawney, Merrimack, Pocklington, Roger's No. 2, Taylor, Transparent, Triumph and Vergennes.

GRAPES AT PINE BLUFF.*

The grape crop, as a general thing, was a perfect success this season. The main vineyard of bunch grapes, consisting of Ives, Cynthiana, Norton's and Concord, all gave excellent crops. Our Scuppernong crop is the best we have ever had. The young vines planted in the experiment vineyard last spring have all done well considering the drouth. Those that have done very well here, and classed as good, are Worden, Amber, Cassady, Cottage, Northern Muscadine, Salem, White Hall, Perkins, Barry, Ives, Norton's, Cynthiana and Scuppernong.

Those that have done fairly well here are Challenge, Canada, Conquest, Black Eagle, El Dorado, Eaton, Niagara, Empire State, Moore's Early, Lady, F. B. Hayes, Prentiss, Roger's No. 44 and Vergennes.

Those that I considered a failure are Catawba, Pocklington, Champion Faith, Highland, Moore's Diamond, Black Pearl, Waverly, Creveling, Ironclad, Humboldt, Isabella, Noah, Montefiore, Berckmans, Etta, North Carolina, Goethe, Peter Wylie, Vernango and Jefferson.

I would consider Ives' Seedling, Norton's, Cynthiana and Scuppernong, with Salem, Perkins, Whitehall, Cassady, Delaware, Northern Muscadine, Barry and Amber, a good selection for a model vineyard for this locality.

NOTES ON VARIETIES OF PEACHES BEARING THIS YEAR.

These trees were set during the spring of 1892, and this season was the first crop from them. The trees are in a very undesirable location; the land has been tile drained, but it is too wet during the spring months for fruit trees. Other land could not be obtained at the time the trees were set, so only a few peach trees were set on the Station grounds. A new peach orchard will probably be set next spring in a desirable location.

---

*Notes from H. G. Hanna.

Only a part of the varieties planted here bore a crop this year.

Brandywine. A light crop of fine peaches. The fruit is large, round, with suture passing nearly around the fruit; color yellow with red cheek; flesh deep yellow, very juicy and of fine flavor. Fruit ripe September 11.

Columbia. It produced a good crop of fine large peaches. They are large and round; color yellow with a blush; flesh yellow, very juicy and of fine flavor. It is a very attractive peach.

Early Rivers. A good crop of fruit. Peaches large; nearly white. It is a promising early variety for this section. Ripe the last of June.

Early Louise. The fruit averages medium in size; flavor good; color yellow with blush which deepens nearly to red on one side. Ripens the last of June.

English Cling. This is a fine large yellow peach; flesh light yellow, juicy and of fine flavor. It is worthy of further trial here.

Lemon Free. A good crop of fine yellow peaches; size large; nearly round; color yellow with no blush; flesh white, juicy, and excellent flavor. It is a desirable variety.

Lovett's White. A fair crop of good peaches; size large, nearly round, suture nearly indistinct; color yellowish white, no blush; flesh white, juicy and very good. This peach resembles Lemon Free very closely, but it is not so large and has a different flavor.

Late Stump. It is identical with Stump the World.

Stump the World. A good crop of large peaches; nearly round, pointed somewhat; color yellow to greenish yellow, with blush; flesh juicy and finely flavored.

NOTES ON APPLES FROM THE STATION ORCHARD LAST YEAR.

Alexander. A fair crop of large apples, but subject to rot on trees; fruit ripens early in August. Owing to its fine appearance it is desirable to grow at least a few trees of this variety where a collection of varieties is planted.

Arkansas Black. Tree an upright grower, healthy, and produces a fair to medium crop. The apples are of fine appearance and always bring the top of the market, and they are good keepers. The fruit is subject to apple scab, and it is rather a shy bearer. Not desirable for general planting.

Bright Water. Tree rather spreading top; bore a fair to good crop, but the fruit was badly attacked by bitter rot. Not desirable.

Gano. Tree resembles Ben Davis very closely. It bore a heavy crop of smooth fruit. The apples are very highly colored and are about equal in quality to the Ben Davis.

Hass. A poor crop of small apples on the trees at gathering time.

Hatcher's Seedling. Tree an upright grower, only moderately vigorous; bore a light crop of fruit. This variety is not desirable, judging from what it has done here, but I have seen it bearing heavy crops of fruit in this and adjoining counties.

Jeneton. The trees of this variety at the Station have not borne a fair crop here up to the present time.

Lawver. This variety is not desirable, as the apples fall badly. The quality of the fruit is poor.

Lankford's Seedling. Tree spreading and healthy. It bore a fair to good crop of apples. The fruit is of poor color, for which reason it would not be desirable as a market variety.

Mammoth Pippin. Tree has rather a spreading top; produces a good crop of fine fruit, free from disease. It is desirable for a fall apple.

Mammoth Black Twig. A heavy crop of fine apples. This variety is not attacked by bitter rot, but is damaged some years by apple scab. It promises to be one of the standard apples for this section; it is a good keeper.

Pennsylvania Cider. Tree rather spreading at the top. It bore an enormous crop of fruit this year. Fruit free from disease and of a fair quality.

Red Winter Pearmain. Tree grows very tall, an upright grower. It produces a good crop of fine apples for late fall or early winter.

Shannon. Produced a fair crop of fruit. The apples are of such excellent quality that a few trees of this variety should be planted in every orchard.

Shackleford. Tree a vigorous grower and produces a very heavy crop, but fruit was badly damaged by bitter rot, so that at ripening time no marketable fruit could be had.

Stevenson's Pippin. Tree rather an upright grower and productive, bearing a full crop of fine large apples.

Stark. A medium grower; tree has rather a spreading top; produces a good crop of apples, but they are poorly colored, which interferes with it being a desirable market variety.

Shockley. This variety bore a very heavy crop of good apples. It is one of the standards for this section, as well as for the southern part of the State.

Woodsey's Seedling. Tree very spreading in growth, with a great number of small limbs, somewhat on the Limber Twig order. It is practically a failure here. There has not been a crop of fruit on the trees here at the Station.

Yellow Forest. Produced a heavy crop of green apples of fair size, which are desirable for cider, but little else.

York Imperial. Tree an upright to spreading grower; it is a finely shaped tree. Crop of fruit good to very good. This variety promises well.

NEWER RUSSIANS.

Antonovka. Tree a vigorous grower, but subject to twig blight. It bears fine large yellow apples, which begin to ripen here about August 10. The fruit is of good flavor, sprightly, sub-acid and somewhat spicy. It is a fine fall apple and is promising for this section.

Antonovka (Vilne). Tree not so vigorous as Antonovka, neither is the fruit so large, but it is similar in color, shape and flavor, and ripens about the same time.

Aport (252). Fruit very large, but few apples on the tree. Ripens rather early in the fall. It is not desirable as a market variety, and is only valuable for a show apple. It grows to an immense size and is very highly colored, being of a rich yellow, blushed with crimson.

Borovinka (*245*). Tree medium to a good grower; fruit begins to ripen with Red June or a little later, and hangs on the tree well. Specimens were taken from the tree in good condition August 8. Color of the fruit is yellow streaked and splashed with red. Flesh quite yellow, acid, a very good cooking apple. It is a promising variety for this section. A fine appearing apple, and would take well in the market.

Professor Budd, in Bulletin No. 19, Iowa Experiment Station, says: "It is of the Dutchess family; fruit almost identical with the Dutchess, but a better keeper."

Blackwood. Medium sized yellow apple, flesh somewhat coarse; mild sub-acid and very good.

Great Mogul. Tree a good grower with extra large leaves; fruit very large, but badly rotted on trees, and before fully ripe nearly all the fruit had rotted. Not desirable.

Lead. Tree vigorous grower and produces a very good crop of fruit. The apples are large, yellow, with blush on sunny side. It is acid and good for cooking, but is not of enough value to be desirable for this section.

Longfield. Tree medium grower, very heavily loaded with medium sized fruit, which is of a bright yellow with a blush. It is a fall apple here, and owing to its producing a very heavy crop it may prove valuable for this section.

Sandy Glass. Tree medium grower with very large leaves. It bore a fair crop of apples, which were of a yellow color with a faint blush. This variety deserves further trial in this section.

The Russian apples that are promising for this section are the summer varieties. The Yellow Transparent is very promising. Some of the early fall varieties may prove valuable. The winter varieties ripen too early here.

INSECTS.

Short descriptions of some of the insects that have been doing damage in the State are given with remedies. The Station is indebted to the Division of Entomology of the United States Department of Agriculture for the cuts of the insects. Electrotypes of the same were obtained through the courtesy of the Division of Publications.

CANKERWORMS.

These insects did much damage to apple orchards in this State during the past season. For the purpose of giving important information of them Circular No. 9, Second Series, Division of Entomology of the United States Department of Agriculture, by D. W. Coquillett, is reproduced in full:

CANKERWORMS—GENERAL APPEARANCE AND METHODS OF WORK.

"Shortly after the apple tree has put forth its leaves in the spring large numbers of a slender, naked spanworm, or measuring worm, sometimes appear upon this and various other kinds and ornamental trees, in the leaves of which they gnaw small holes. As they increase in size the entire leaf, with the exception of the stout mid-rib, is devoured.

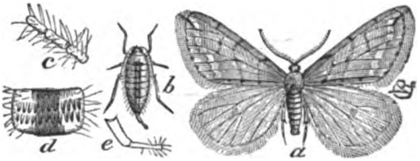


FIG. 1. *Paleacrita vernata: a*, male moth; *b*, female moth—both natural size; *c*, joints of female antenna; *d*, joint of female abdomen; *e*, ovipositor enlarged. (From Riley.)

"Two different insects are often concerned in this destructive work, namely: The fall cankerworm, represented at Figure 4, and the spring cankerworm shown at Figure 2. The latter will be readily distinguished by possessing only two pairs of legs on the under side of the posterior half of the body, there being three pairs in the species first mentioned. Both are evidently natives of this country, and have never been reported as occurring outside of North America.

THE SPRING CANKERWORM.

(*Paleacrita Vernata*. Peck.)

"*Distribution*—This is the species usually concerned in the widespread defoliation of fruit trees, particularly in the Mississippi Valley and throughout the West. It ranges from Maine to Iowa, and southward to Texas, but is more restricted along the Atlantic seaboard, where it has not as yet been reported as occurring south of New Jersey. Owing to the fact that the adult female insects are wingless, the spread of the species is necessarily slow, and is principally accomplished through the medium of nursery stock infested with the insects' eggs.

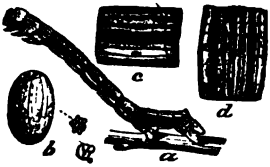


FIG. 2. *Paleacrita vernata:* *a*, larva—natural size; *b*, eggs—natural size and enlarged; *c*, side view of segment of larva; *d*, dorsal view of same—both enlarged. (From Riley.)

"*Natural History and Habits*—Although the females are wingless, the males are furnished with two pairs of rather large, thin wings; the general color is bluish gray, with light and dark markings, as shown at Figure 1 (*a*.) Oviposition sometimes occurs during mild winters, but as a general rule not until March or April. The eggs (see Figure 2 *b*) somewhat resemble in miniature those of a hen, and are deposited in irregular masses, usually concealed beneath pieces of loose bark and similar objects. They hatch about the time the apple tree unfolds its leaves in the spring, the date varying with the locality and season, from the middle of April to the latter part of May. The young cankerworms eat greedily and grow rapidly, usually attaining their full size in from three to four weeks from the time of issuing from the eggs. They enter the ground to a depth of from 2 to 5 inches, according to the character of the soil; here each one forms a small cell, which it lines with a few strands of silk, and shortly afterwards transforms to the chrysalis, in which condition it remains until the following winter or early spring, when the change to the adult insect takes place.

Only one generation is produced each year.

"*Natural Enemies*—Large numbers of cankerworms normally fall a prey to various kinds of birds, and several kinds of beetles feed upon them. Certain kinds of wasps provision their nests with them to serve as food for their young. Ichneumon flies and Tachina flies, while in the larva state, also destroy many by feeding upon them internally. The eggs are destroyed by mites, and a minute Chalcis fly preys upon them, each egg serving as food for one of the flies. All these checks to the undue increase of the cankerworms, when present in any given locality, usually succeed in keeping them within due limits; but when these are absent, or the weather conditions are unusually favorable to the increase of the worms, artificial means will be found necessary to keep them in subjection.

"*Remedies and Preventive Measures*—Owing to the fact that it is only in exceptional years that cankerworms appear in destructive numbers, but little attention is usually paid to them until the blighted appearance of the infected trees proclaims their presence to the orchardist. At such times the damage is already well under way and will be increased somewhat before an insecticide can take effect. As an immediate partial remedy the jarring method may be employed. This consists in first placing a strip of stiff paper around the trunk of the tree, and smearing it with some kind of sticky substance, such as tar, printer's ink, thick molasses, or bird lime, to prevent the worms from again ascending. The tree is then jarred or shaken, causing some of the larvæ to drop to the ground, while others let themselves down by silken threads, which must be severed by means of a cane or stick, to prevent the worms from reascending the tree.

"A general spraying with arsenicals as soon as the worms appear will rid the trees of these pests in a very short time. Paris green is the more satisfactory of the arsenicals, as it is less liable to injure the foliage than London purple, and its use has proven safe and effective at the rate of 1 pound to 150 gallons of water. Before mixing the Paris green with the water it is advisable to add an equal weight of freshly slaked lime, mixing thoroughly. The lime takes up any free arsenic and prevents possible injury to the foliage. During the process of applying the poison, which can be best accomplished by means of an ordinary spray pump and nozzle, the solution should be kept constantly stirred to prevent the poison from settling to the bottom. The worms are most readily poisoned when newly hatched, and it is therefore very important to spray as soon as the young worms first appear, with the object also of preventing the damage which would result from delay.

"After the worms have assumed the chrysalis form just beneath the surface of the ground, large numbers may be destroyed by plowing and harrowing the orchard. This may be done at any time during August or the first half of September.

"The principal remedies employed against these pests in the past have had for their object the preventing of the wingless female moths from ascending the trees to deposit their eggs. Various mechanical devices have been used, and these, while troublesome and expensive, and in general superseded by the arsenical treatment, may still be of service in special cases, or where spraying cannot well be practiced. One of the simplest devices, and one giving as good satisfaction as any other, consists in surrounding the trunk of each tree with a band of stiff paper. This band should be 6 or 8 inches wide, and its lower edge should rest upon the ground, or be pressed a short distance into it in order to prevent the moths from gaining access to any portion of the tree except by first passing over this band. The adhesive substance should then be applied to the upper portion of it. The moths, finding themselves unable to pass over this barrier, will deposit their eggs on the lower part of it.

"The bands should be applied to the trees about the first of March, and the adhesive substance renewed until the trees begin to leaf out, after which the bands should be removed and destroyed. In the matter of applying them the orchardist should be guided by his own observations, since the time of the appearance of the moths will vary according to the locality and season.

THE FALL CANKERWORM.*

(*Anisopteryx pometaria.* Harr.)

"This insect so closely resembles the preceding species as to be often mistaken for it. A careful comparison of the accompanying illustrations, however, will render the separation of the two forms comparatively easy. The habits and natural history of the two species are so nearly identical that for the present purposes it will only be necessary to indicate their principal differences. The fall cankerworm is more essentially a Northern insect, occurring from Rhode Island to Canada, and westward to Lake Superior; and, quite recently, it has been found in large numbers in some of the orchards of Northern California. The eggs are deposited principally in late autumn or early winter, although during mild winters egg laying sometimes continues as late as the month of March. The eggs somewhat resemble miniature flower pots, being small at the lower end, and gradually enlarging to the top, which is quite flat. They are attached to the bark in masses of from 60 to 200, placed side by side in exposed situations. Hatching occurs at about the same time as with the preceding species, and the worms attain their full growth and enter the earth at about the same time as the latter, but, instead of simply lining their cells with a few strands of silk, they spin dense cocoons of a yellowish silk. The change to the chrysalis takes place about one month after the spinning of the cocoons, and the adults issue for the most part from the middle of October to the middle of December, although during mild winters a few issue as late as March.

---

*Figure 3, representing this insect, is not given as it could not be obtained in time for use.

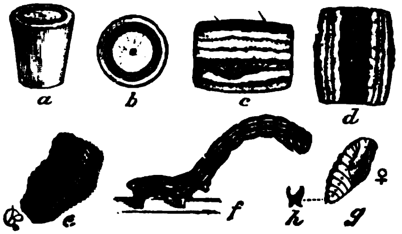


FIG. 4—*Anisopteryx pometaria:* *a*, *b*, egg; *c*, *d*, side and dorsal views of larval segment—enlarged; *e*, egg-mass; *f*, larva; *g*, female pupa—natural size; *h*, anal tubercle—enlarged. (From Riley.)

"Owing to the fact that the chrysalides are enclosed in tough cocoons, plowing the soil containing them will produce little or no effect upon the inclosed insects. The arsenicals, notably Paris green, are, as with the former species, the most efficient and economical means of controlling this insect. If it be desirable, however, to proceed against the moths, the barriers applied to the trees for the purpose of preventing the adult insects from ascending and depositing their eggs should be put in place early in October, or before the first moth makes its appearance, and the adhesive substance applied to the bands should be renewed as long as any of the moths are to be found, after which the bands may be removed and destroyed by burning or otherwise. Care should be exercised in removing the bands before the season for the eggs to hatch, otherwise the very object which the bands were intended to accomplish will be defeated."

THE GRAPE CANE BORER.

We have received several specimens of the cane twigs from over the State showing injury from this insect. A brief description of it, with remedies, is here reproduced as given by Mr. C. L. Marlatt in the Year Book of Department of Agriculture for the year 1895.

THE GRAPE CANE BORER.

(*Amphicerus bicaudatus* Say.)

"The young shoots of the grapes during the spring months in some districts will be observed to suddenly break off or droop and die, and if examination be made a small hole will be found just above the base of the withered shoot, with a burrow leading from it a short distance into the main stem. Within the burrow will be found the culprit in the form of a peculiar cylindrical brown beetle about half an inch long. This beetle has long been known as the apple twig borer, from its habit of boring into the smaller branches of the apple in the manner described for the grape. It also sometimes similarly attacks pear, peach, plum, forest and shade trees and ornamental shrubs. To the grape, however, it is especially destructive, and the name "grape cane borer" is now given to it as more appropriate. Much complaint of this beetle is always received during the winter and early spring. Frequently all the new growth is killed, and in some cases vines have been entirely destroyed. It is extremely common in the States bordering the Mississippi, from Iowa to Arkansas, and also in Texas, often becoming throughout this region the most important insect enemy of the vine. It also occurs eastward to the coast, but rarely causes much damage in its Eastern range.

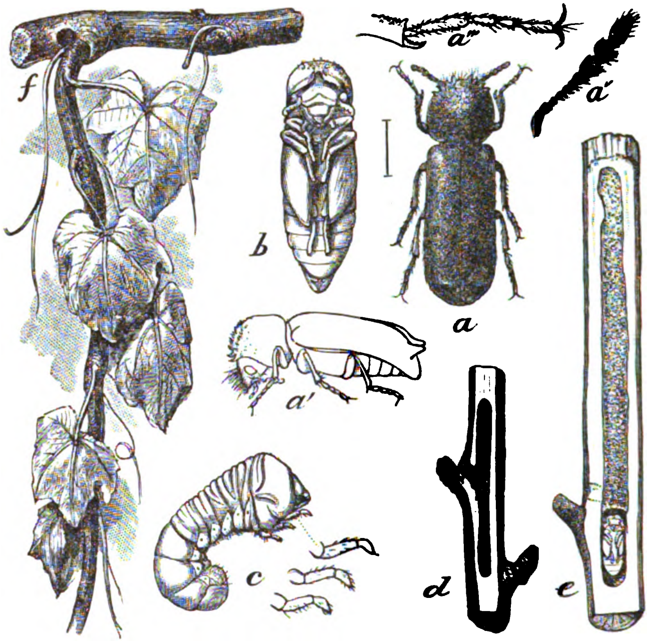


FIG. 5—*Amphicerus bicaudatus: a*, beetle, dorsal and lateral view; *b*, pupa from beneath; *c*, larva from side, with enlargements of the thoracic feet; *d*, burrow in apple twig made by adult; *e*, larval gallery in tamarisk, with pupa in cell at end; *f*, injury to young shoot and cane, showing the entrance to burrow of beetle near *f* and the characteristic wilting of the new growth—all much enlarged except *d*, *e* and *f*. (Marlatt.)

"It breeds in dying wood, such as large prunings, diseased canes, and also in dying or drying wood of most shade and fruit trees. It has been found by the writer breeding very abundantly in roots of uprooted maples and in diseased tamarisk stems. In old dry wood it will not breed, so far as is known, nor in vigorous live growth, but seems to need the dying and partially drying conditions mentioned. The insect has but one brood yearly. The beetles mature for the most part in fall and generally remain in the larval burrows until the following spring. A few may leave the burrows in the fall and construct others in the twigs of apples or other plants in which to hibernate. In the spring, however, they begin their destructive work early, burrowing into the axils of the grape, and occasionally also into other plants. This is undoubtedly partly for food, but seems largely malicious, for it certainly has nothing to do with egg laying, although it may have some connection with the marital relation. The eggs are laid chiefly in May, or as early as March or April in its Southern range, and the larvæ develop during summer, transforming to pupæ and beetles in the fall.

On the Pacific Coast a closely allied but somewhat larger species (*Amphicerus punctipennis* Lec.) breeds in grape canes and other plants, and probably has similar burrowing habits in the adult stage.

"*Remedies*—It will be apparent at once that to limit the work of this insect it will be necessary to promptly destroy all wood in which it will breed. This means the careful removal and burning of all diseased wood and prunings at least by midsummer, thus destroying the material in which the larvæ are probably undergoing their development. If precautions of this sort are neglected and the beetle appears in the vineyard in spring, the only recourse is to cut out by hand every affected part and destroy the beetles. On warm days they may sometimes be collected in numbers while running about the vines."

GRAPE LEAF FOLDER.

The grape leaf folder is found in many parts of the State. It does its damage to grapevines by folding the leaf and tying it over by silken threads for protection and then eating the leaf until its use is entirely destroyed. Great damage is done to vineyards where the insects are numerous.

There are two broods here each season (probably three farther south), the late brood being the one that does the greatest amount of damage. The first brood usually appears in small numbers.

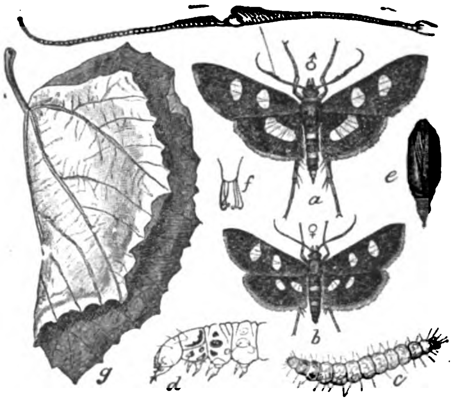


FIG. 6—*Desmia maculalis* *a*, male moth; *b*, female; *c*, larva; *d*, head and thoracic segment of same, enlarged; *e*, pupa; *f*, tip of pupa, enlarged; *g*, grape leaf folded by larva. (Marlatt.)

Remedies—It has been the practice in the Station vineyard to pick all the leaves containing the worms of the first brood and burn them. By doing this very carefully the danger of injury from the second brood is lessened.

The second brood usually appears about the time the later varieties are ripening, and the vines of all early ripening varieties are usually sprayed with London purple or Paris green, to which lime has been added. We have always succeeded in checking the work of the insects and have not had any serious damage done to any of the vines by the worms.

GRAPEVINE FIDIA.

This insect has been found doing damage to grapevines in this State during several seasons. The damage caused by it to the vines is considerable. We have tried remedies for the beetles during several seasons, and have been able to check the injury done by them to a fair extent only. We were unable to get at the life history of the insect until it was worked out by Professor Webster, of Ohio. The insect is called the Grape Root Worm, and the life history of the insect is given as worked out by him. The cut shows the beetle with the eggs and larva, with a leaf and roots showing injury. The adult insect is a small, round beetle, which makes its appearance during the last of May and first of June. It begins

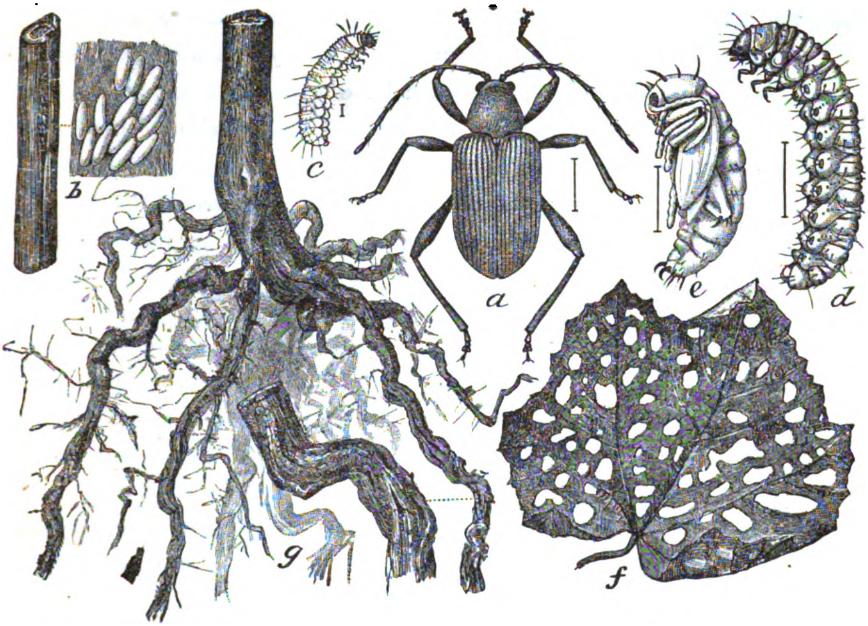


Fig. 7—*Fidia viticia*: *a*, beetle; *b*, eggs represented natural size under fold of bark and much enlarged at side; *c*, young larva; *d*, full grown larva; *e*, pupa; *f*, injury to leaf by beetles; *g*, injury to roots by larva; *b* (in part), and *f* and *g* natural size, rest much enlarged. (Marlatt.)

feeding on the lower leaves of the vines, and works upward. When alarmed the insects usually drop to the ground and lie perfectly quiet, as if dead. Professor Webster says that in the insectary the adults live upwards of two months, though in the vineyards they have mostly disappeared by August 1, and he records them as appearing there during the fore part of June. The beetle eats small elongated holes in the leaves, as is shown by (*f*) in the figure, doing great damage to them. They are partial to Cynthiana and Norton varieties. The eggs are usually deposited in the loosened bark of the vines, as shown at (*b*). "These eggs hatch during the early fall, and the larvæ enter the ground and feed on the roots. First on the fibrous roots, near the base of the vines, and afterwards on the larger ones. After reaching full growth they construct little cavities in which they hibernate until the following spring, when they change to the pupa state a short time before appearing as beetles." There is only one annual brood here. This insect may be destroyed in the beetle state by spraying with Paris green or London purple, although we have had only fair success in our efforts to destroy them by this method. Professor Webster says that the beetles can be destroyed by a very strong solution of arsenical poison, and the worms can be killed with the fumes of bisulphide of carbon, and frequent stirrings of the soil during July and later, and keeping a thick covering of mellow earth over the roots during this period, will also be of service in preventing the young from reaching the roots.

BAGWORM.

This insect is doing much damage to shade and ornamental trees each year in the State. Its damage is not confined to trees, as it is found on ornamental shrubs as well. A cut of the insect is given to enable all to recognize it, so that steps may be taken to destroy it, by those who may desire.

The cases are seen during the winter hanging to the branches of the trees after the leaves have fallen. They are fastened to the twigs by a very strong silken fastening. Most of these cases contain the eggs for another brood. The cases of the females contain eggs, those of the males are empty.

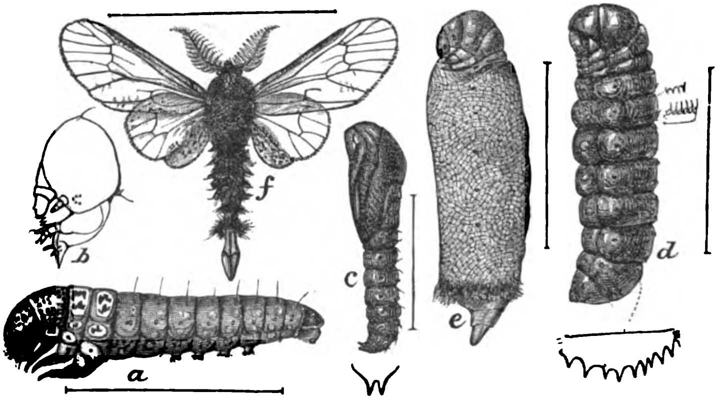


FIG. 8--Bagworm (*Thyridopteryx ephemeræformis*). *a*, larva; *b*, head of same; *c*, male pupa; *d* female pupa; *e*, adult female; *f*, adult male, all enlarged. (Howard.)

The worms hatch during May and they soon begin to eat. The cases are formed by them during the season. The small cases shown in the cut (*a*, *b*) show how they are attached to the tree while feeding and the successive stages of growth. The cuts show the different stages of the insect and the cases.

Remedies. Spraying with either London purple or Paris green has given very satisfactory results at the Station and it is the remedy generally recommended.

The first application is given as soon as the small worms are noticed on the leaves, and followed by another in from one to two weeks.

As the cases are easily seen in winter they may be picked off and destroyed by burning. This is a very sure method as all the eggs can thus be destroyed. One case contains a great number of eggs.

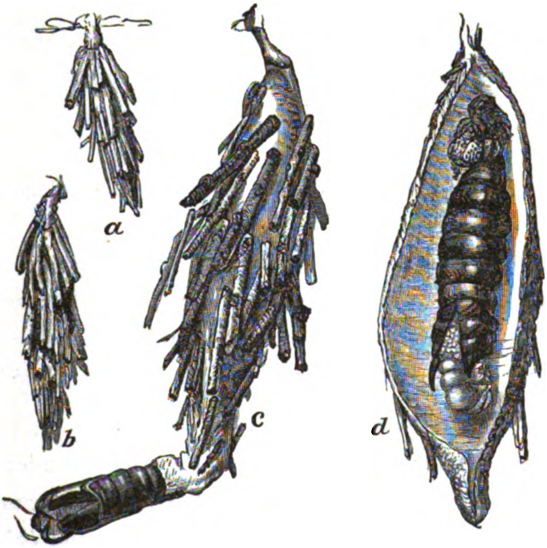


FIG. 5. Bagworm at (*a, b, c,*) successive stages of growth; *c,* male bag; *d,* female bag, natural size. (Howard.)

When spraying with the arsenites it is always best to add a little fresh lime to the mixture as the arsenite can be used much stronger without danger of injuring the foliage.

PEAR BLIGHT.

This disease has baffled all attempts at a cure, and the only remedies that have proven successful are preventative ones. Much loss has been caused by it in the State. The Experiment Station is in receipt of many letters each year regarding it.

It is caused by a small microbe *(Bacillus amylovorus)* which was discovered to be the cause of the disease by Professor Burrill. The blight appears on the blossoms and the first effect is noticed here. It spreads rapidly at this season, for the microbes are carried to healthy blossoms by insects. The disease extends to the leaves and branches. It also gains entrance into the growing branches. The greatest damage is done during the spring months, but the branches are liable to injury at any time during the growing season. The blight often continues through the summer, and in some cases through the winter months. It begins the destruction again early in the spring. The microbes are carried from the diseased portions to the blossoms, and healthy trees are infected. Some varieties are more liable to be injured than others. Kieffer resists the disease better than most varieties. In practice it is found that trees that are grown in sod are less liable to injury.

The same disease attacks apple trees during spring and summer months, and is called "apple twig blight."

This disease has been closely studied by M. B. Waite, assistant in the Division of Vegetable Physiology and Pathology, United States Department of Agriculture. He recommends a course of treatment which is given in the Department Year Book for 1895, and which is here reproduced.

TREATMENT FOR PEAR BLIGHT.

"The treatment for pear blight may be classed under two general heads: (1) Methods which aim to put the tree in a condition to resist blight or to render it less liable to the disease and (2) methods for exterminating the microbe itself, which is of first importance, for if carried out fully there can be no blight. The methods under the first head must unfortunately be directed more or less to checking the growth of the tree, and therefore are undesirable except in cases where it is thought that the blight will eventually get beyond control in the orchard. Under the head of cultural methods which favor or hinder pear blight, as the case may be, the following are the most important:

"*Pruning*—Pruning in winter time, or when the tree is dormant, tends to make it grow and form a great deal of new wood, and on that account it favors pear blight. Withholding the pruning knife, therefore, may not otherwise be best for the tree, but it will reduce to some extent its tendency to blight.

"*Fertilizing*—The better a tree is fed the worse it will fare when attacked by blight. Trees highly manured with barnyard manures and other nitrogenous fertilizers are especially liable to the disease. Over-stimulation with fertilizers is to be avoided, especially if the soil is already well supplied.

"*Cultivation*—The same remarks apply here as in the case of fertilizing. A well cultivated tree is more inclined to blight than one growing on sod or untilled land, although the latter often do blight badly. Generally good tillage every year is necessary for the full development of the pear and quince trees, and is more or less so for the apple in many parts of the country, but the thrift that makes a tree bear good fruit also makes it susceptible to blight. Check the tree by withholding tillage, so that it makes a short growth and bears small fruit, and it will be in a better condition to withstand blight than it would were it cultivated. In cases where thrifty orchards are attacked by blight and threatened with destruction, it may often be desirable to plow them once in the spring and harrow soon after the plowing, to plow them only, or to entirely withhold cultivation for a year, mowing the weeds and grass or pasturing with sheep. A good way is to plow the middle of the space between the rows, leaving half of the ground untouched.

"*Irrigation*—In irrigated orchards the grower has the advantage of having control of the water supply. When such orchards are attacked, the proper thing to do is to withhold the water supply, or reduce it to the minimum. Only enough should be supplied to keep the leaves green and the wood from shriveling.

"*Extermination of the Blight Microbe*—We now come to the only really satisfactory method of controlling pear blight—that is, exterminating the microbe, which causes it, by cutting out and burning every particle of blight when the trees are dormant. Not a single case of active blight should be allowed to survive the winter in the orchard or within half a mile or so from it. Every tree of the pome family, including the apple, pear, quince, Siberian crab apple, wild crab apple, the mountain ash, service berry, and all the species of Cratægus, or hawthorns, should be examined for this purpose, the blight being the same in all. The orchardist should not stop short of absolute destruction of every case, for a few overlooked may go a long way toward undoing all his work. Cutting out the blight may be done at any time in winter or spring up to the period when growth begins. The best time, however, is undoubtedly in the fall, when the foliage is still on the trees, and the contrast between that on the blighted, and that on the healthy limbs, is so great that it is an easy matter to find all the blight. It is important to cut out blight whenever it is found, even in the growing season. At that time of year, however, it cannot be hoped to make much headway against the disease, as new cases constantly occur which are not sufficiently developed to be seen when the cutting is done. In orchards where there are only a few trees, and the owner has sufficient lime to go over them daily, he will be able to save some which would otherwise be lost. However, when the trees stop forming new wood, the campaign should begin in earnest.

"Of course the greater part of the blight can be taken out the first time the trees are gone over. If this be in midsummer, the trees should all be again carefully inspected in the autumn, just before the leaves shed, so as to get every case that can be seen at that time. After this a careful watch should be kept on the trees, and at least one more careful inspection given in spring before the blossoms open. It would doubtless be well to look the trees over several times during the winter to be certain that the blight is completely exterminated. In order to do the inspecting thoroughly it is necessary to go from tree to tree down the row, or in case of large trees to walk up one side of the row and down the other, as in simply walking through the orchard it is impossible to be certain that every case of blight has been cut out.

"The above line of treatment will be even more efficacious in keeping unaffected orchards free from the blight. A careful inspection of all pomaceous trees should be made two or three times during the summer and a sharp lookout kept for the first appearance of the blight. It usually takes two or three years for the disease in an orchard to develop into a serious epidemic, but the early removal of the first cases will prevent this and save a great deal of labor later and many valuable trees.

"In doing this work it must be remembered that success can be attained only by the most careful and rigid attention to details. Watch and study the trees, and there is no question that the time thus spent will be amply repaid."

Agricultural Experiment Station

FAYETTEVILLE ARKANSAS.

TENTH ANNUAL REPORT

1897

Agricultural Experiment Station

FAYETTEVILLE ARKANSAS.

TENTH ANNUAL REPORT

1897

ARKANSAS EXPERIMENT STATION,
FAYETTEVILLE, ARK., November 10, 1897.

To His Excellency, DAN W. JONES,

Governor of Arkansas:

SIR—

I have the honor to transmit to you herewith the Tenth Annual Report of the Arkansas Agricultural Experiment Station.

Most respectfully,
R. L. BENNETT,
Director.

CONTENTS.

Page.

LETTER OF TRANSMITTAL 2

BOARD OF TRUSTEES 4

STATION STAFF 4

FINANCIAL REPORT 5

REPORT OF DIRECTOR 6

SUBJECTS OF EXPERIMENT 6

REPORT OF ASSISTANT AGRICULTURIST 3

REPORT OF HORTICULTURIST 119

REPORT OF ANIMAL PATHOLOGIST AND BACTERIOLOGIST 49

REPORT OF AGRICULTURIST 79

REPORT OF CHEMIST 101

Agricultural Experiment Station.

BOARD OF TRUSTEES.

His Excellency, DAN W. JONES, *President*.

HON. W. H. LANGFORD.
HON. C. C. HAMBY.
HON. V. Y. COOK.
HON. W. N. YATES.
HON. J. B. McDONOUGH.
HON. T. A. FUTRALL.

BOARD OF CONTROL.

HON. T. A. FUTRALL.
HON. W. H. LANGFORD.
HON. V. Y. COOK.
THE PRESIDENT OF THE UNIVERSITY.
THE DIRECTOR OF THE STATION.

STATION STAFF.

R. L. BENNETT	DIRECTOR.
GEO. L. TELLER	Chemist.
R. R. DINWIDDIE	Animal Pathologist and Bacteriologist.
J. T. STINSON	Horticulturist.
C. L. NEWMAN	Agriculturist.
GEO. B. IRBY	Assistant at Newport.
J. F. MOORE	Assistant Chemist and Librarian.

Correspondents will please notify the Director of any change of Post Office Address, error in Address, or failure or delay in receiving Bulletins.

R. L. BENNETT, Director,
Fayetteville, Ark.

FINANCIAL REPORT

Agricultural Experiment Station.

In Account with the United States Appropriation.

1897 **DEBTOR.**

To Receipts from the Treasurer of the United States as per Appropriation for the year ending June 30, 1897	$15,000	00
	$15,000	00

CREDIT.

By Salaries	$ 8,599	80
Labor	1,553	48
Publications	1,637	35
Postage and Stationery	214	40
Freight and Express	259	49
Heat, Light and Water	58	25
Chemical Supplies	383	90
Seeds, Plants and Sundry Supplies	620	60
Fertilizers	11	75
Feeding Stuffs	113	03
Library	248	71
Tools, Implements and Machinery	24	36
Furniture and Fixtures	68	80
Scientific Apparatus	136	52
Live Stock	12	60
Traveling Expenses	503	75
Contingent Expenses	98	75
Building and Repairs	497	11
	$15,000	00

The foregoing Statement is copied from the Experiment Station books, which have been duly examined and found correct by the Auditing Committee of the Board of Trustees.

R. L. BENNETT,

Director.

REPORT OF DIRECTOR.

This report contains the completed work and financial statement of the fiscal year ending June 30, 1897.

The completed work of the year is contained in six Bulletins, and a full text of each appears in the succeeding pages.

The Bulletins and their subject-matter are as follows:

Bulletin 44—Vegetable Gardening.

Bulletin 45—Milk; Its Decomposition and Preservation.

Bulletin 46—Experiments with Manures and Rotation for Improving Worn Cotton Soil.—Experiments on Beef and Pork Production in Connection Therewith.

Bulletin 47—Concerning Fertilizers and Manures.—After-Effect of Manuring.

Bulletin 48—Strawberries.

The chief experiments of the year have been continued on the general subjects mentioned in my last report, 1896, and are adapted to the practical needs of the farmers of the State. The soil of Arkansas is not so worn, and profitable farming is not so difficult, or the practice of economy so necessary as it is on the poorer soils of the older settled States, but notwithstanding these favorable conditions, the farmers of Arkansas take an eager interest in the experiments that are made and published in the Station Bulletins. In support of this fact the several thousand names of farmers on the Station's mailing list are there at their own request and not by any direct effort of the Station to collect and put them there.

R. L. BENNETT,

Director.

CONTENTS.

Page.
- INTRODUCTION 4
  - Soils and Preparation 9
  - Manuring and Fertilizing 10
  - Rotation of Crops 11
  - Hotbeds 11
  - Cold Frames 13
  - Shallow Boxes for Seedlings 13
  - Plant Beds 13
  - Seed 14
  - Seed Sowing 15
- VEGETABLE CULTURE IN ARKANSAS 16
  - Asparagus 16
    - Growing the Young Plants 16
    - Transplanting 17
  - Bush or Snap Beans 18
  - Pole Beans 19
  - Lima Beans 19
  - Beets 19
  - Spring Cabbage 20
    - Sowing the Seed 20
    - Soil 21
    - Transplanting 22
    - Cultivation 22
  - Summer Cabbage 23
  - Fall and Winter Cabbage 23
    - Marketing 24
  - Cauliflower 25
  - Collards 26
  - Carrot 26
  - Celery 27
    - Growing the Young Plants 27
    - Transplanting 28
    - Handling and Earthing 29
    - Varieties 30
    - Marketing 30
  - Cantaloupes and Cucumbers 30
  - Garden Corn 32

Page.
  - Upland Cress 32
  - Eggplant 32
  - Kale or Borecole 33
  - Lettuce 33
  - Okra 34
  - Onions from Seed 34
    - Soil and its Preparation 35
    - Sowing the Seed in Hotbeds or Greenhouse 35
    - Transplanting 36
    - Sowing the Seed in the Open Ground 37
    - Cultivation 37
    - Harvesting 38
    - Marketing 38
    - Varieties 38
    - Growing Sets 38
    - Planting Sets 39
  - Parsnip 39
  - Pepper 39
  - Irish Potato 39
  - English Pea 39
    - Gathering and Marketing 40
    - Varieties 40
  - Radish 40
  - Salsify or Oyster Plant 41
  - Spinach 41
  - Squash 42
  - Tomato 42
    - Sowing the Seed 42
    - Preparation of the Field 43
    - Final Transplanting 43
    - Cultivation 44
    - Pruning 45
    - Tying 45
    - Gathering and Marketing 45
    - Varieties 46
    - Fall and Winter Tomatoes 46
  - Turnips 47
  - Watermelons 48

INTRODUCTION.

BY C. L. NEWMAN.

A very large proportion of the inhabitants of Arkansas have emigrated from various sections of the United States and some have come from foreign countries. Many find the methods of culture and fertilizing, time of sowing and harvesting and varieties of vegetables grown under the conditions of their past surroundings, not suited here. This is forcibly illustrated by their correspondence with the Station and by the information sought. This Bulletin is written to supply this information, and its subject matter is largely drawn from the results of experiments conducted on the Experiment Station grounds through the past three years and under the supervision of the writer. While the directions are based upon the results of actual experiments conducted within the State and planned for the purpose of supplying this information, they are not claimed as infallible, but subject to such change and alteration as future experience or experimentation may authorize.

The pleasure and economic importance of vegetable growing is but slightly appreciated in many sections of Arkansas, and, as a consequence, it is given but careless and ignorant attention. It is no difficult matter to curtail the table expenses one-fourth by giving a garden of an acre, or less, the care and attention it deserves. Favored as the State is in soil and climate conditions; fresh vegetables of a great variety should daily be gathered from a well kept garden ten months of every year, and frequently throughout the entire year. On the other hand, conducted as the gardening operations are, the results afford but little of either profit or pleasure. A very large majority of the homes throughout Arkansas, whether urban or rural, have near at hand an inclosure called "the garden." As spring approaches last year's growth of weeds are piled and burned, the surface of the soil stirred, and potatoes, peas, corn, beans, onion sets and tomatoes are planted. When these are in danger of being crowded out by weeds they are cultivated. As the time for them to reach edible maturity approaches, cultivation ceases, weeds take possession and hold undisputed sway until the following spring, unless a portion of them are plowed and turnips broadcasted for early spring "greens." As a consequence of the practice, only vegetables inferior both in quality and quantity are produced, discouragement follows and the garden is abandoned or converted into a calf pasture. This is no pen picture of the imagination, but a statement of actual conditions and common in this and other cotton producing States. It is true, however, that there is an occasional well kept garden, yielding in variety and abundance throughout the greater portion of the year. While all are lavish in their praise of such a garden, it rarely occurs to them that they might read the object lesson and follow the example.

It is comparatively an easy matter to grow a good garden if the owner takes the trouble to post himself and gives the necessary attention at the proper time. The best soil for vegetables is a deep, light, thoroughly drained sandy loam, well filled with vegetable matter. Deep and light soils abound throughout three-fourths of the State. If drainage and humus are wanting they must be supplied. Few soils can be made to give the best results as vegetable soils until they have been properly cultivated and manured for vegetables for several years, no matter how rich they may be considered by their owner, or how well they produced cotton or corn.

The success of all subsequent operations in gardening depend upon the preparation of the soil. Unless stiff, tenacious clay is near the surface, plowing cannot be too deep in soil of even moderate fertility. If a soil is originally but 5 inches deep, and by plowing and incorporating manure it is made 10 inches, its quantity is doubled and its producing capacity doubled or more than doubled. Soil for vegetables should be at least 10 inches deep and pulverized throughout. A soil in a poor physical condition may contain fertilizing materials in quantities sufficient for the production of good crops, but not in an available form, and useless for plant growth until the soil becomes friable and aerated. A soil that is the most friable and mellow and possesses the greatest porosity has the greatest capacity for fertilizing materials and resists leaching and drouth. Thorough and deep pulverization not only renders available the inert plant food contained in the soil, but enables the roots to ramify through greater area and distance in their search for food. Plowing and harrowing should be continued until there is no doubt but that the soil is in the proper condition, even should it be necessary to repeat both plowing and harrowing several times. The failure of many crops is due to inadequate preparation of the soil, and that alone. It is too often the case that preparation of the soil is delayed until the time for planting, when the haste to get the seed in is greater than the care of preparation.

The application of manures in quantities sufficient to give the best results is of rare occurrence with the inexperienced gardener. One or two hundred pounds of cotton seed meal or a few wagon loads of stable manure is oftener more than the yearly allowance for an acre than it is less. It is not uncommon for successful market gardeners to yearly apply 25 tons of stable manure to one acre, and 50 and 75 tons per acre have paid a large per cent on the investment. These heavy applications of stable manure are frequently supplemented with several hundred, or even 1,000 or 2,000 pounds of commercial fertilizers, and a profit of several hundred dollars secured in one year from one acre. The profitable application of these large quantities of manure is referred to for the purpose of calling attention to the fact that under favorable conditions it is quite difficult to fertilize too heavy if the application is wisely and properly made. A poor soil, however, may be so heavily fertilized as to seriously injure the crop if concentrated or unfermented materials are used, as will a poor animal be injured by over feeding. As a rule, the more fertile a soil and the more accustomed it is to heavy fertilization the greater the quantity of manure that can be applied without injury. The gardener should begin with moderately heavy application and increase as the soil or the crops will admit of or demand, and gradually increase the quantity for each succeeding crop. Whether applied broadcast or in the drill, it is better that the fertilizing materials be put down a few days or a few weeks before the seed are planted or the plants set out, as the case may be. If to be broadcast, it should be evenly distributed over the surface of the soil before its preparation begins, that it may be more equally distributed and thoroughly incorporated. If in the drill, one or more furrows must be run after the application for the same purpose. Having properly manured and prepared the soil and planted the seed with due regard to its capacity, cultivation will next demand the attention of the gardener.

The object of cultivation is not merely to suppress the growth of weeds that threaten to rob the crop of its nutriment, but also, and at all times, to keep the soil mellow and loose. While plants are in their early stage of growth, the soil cannot well be too frequently stirred, if their roots are not molested, and in their subsequent development, cultivation must be continued at close intervals. Soil may be cultivated when too wet, and frequently is, but never when too dry, if cultivation is shallow, as nearly all cultivation should be. Each rain should be followed by a thorough loosening of the surface of the soil. This not only kills the young weeds before they have injured the crop, but prevents the baking of the soil, admits air and retains moisture. Should dry weather prevail, cultivation should continue. With proper preparation and judicious manuring, the success or failure of a crop may still depend upon its treatment in dry weather—deep cultivation might ruin or shallow might save. A loose covering of soil intercepts the moisture arising from below, thus performing the office of a mulch; increases the deposit of dew, gives freer admission to air and rain, and facilitates chemical action.

No weeds should at any time be allowed to mature seed. If this is carefully attended to, there will be in one or two years quite a decrease in the number of these pests.

Rotation should be practiced with system in every garden; not alone for the soil's recuperation, but also to lessen the attacks of insects and fungous diseases.

The various vegetables, whether grown for market or home use, occupy the soil different lengths of time, making it possible to produce half a dozen or more crops on the same plot of soil within the space of twelve months. As illustration of this rapid rotation, the following schedule gives the crops grown at the Southern Branch Station in 1894 on a plot of ground 10x45 feet:. (1) Radishes were planted in the early spring in rows 2 feet apart; later, (2) lettuce was transplanted into rows marked off between the radishes; the radishes came off in six weeks, and their rows prepared and planted in (3) snap beans; every other row of lettuce was planted in (4) corn when the lettuce was cut; the beans were followed by (5) lettuce, and the corn and lettuce by (6) onions and (7) radishes. In 1885 another plot, 15x45 feet, was occupied by (1) onions in January and part of February. The onions were used for bunching, and the plot planted in (2) Irish potatoes on the 25th of February. Early in March, (3) English peas and (4) corn were planted in every alternate potato middle. (5) Beans were planted in corn rows late in April—two hills of beans between each hill of corn. In the latter part of June, the corn and beans were followed by (6) cowpeas broadcast. (7) Spinach was planted early in October after the peas, and (8) radishes and (9) lettuce alternated in the spinach middles. This rapid change of crops will, to some extent, have a tendency to decrease the attacks of both fungi and insects, if only such plants are used as are not of close botanic relation. The majority of the plants will have been removed before the insects or fungi attacking them have reached the degree of development necessary for propagation.

When a plant ceases to fruit or there is no further use for it, it should be at once removed, if diseased, and destroyed. The plot should then be manured, prepared and planted again. No garden spot should remain idle. If there is no particular use to which it can be put after the removal of a crop, nothing is better than planting in cowpeas if vacant in spring or summer, and rye or crimson clover in fall. The rye and clover plowed under green will enrich the soil after affording winter protection. No matter in how quick succession one crop follows another, the soil, as a rule, should be manured before each planting, using fermented and well decomposed manures. Fresh or unfermented manures often act disastrously to growing crops. No manure is better than well rotted stable manure, and results from it frequently are better the second than the first year. Its bulk materially affects the physical properties of the soil, and the quality of many vegetables is dependent more upon the physical condition of the soil in which they are grown than upon its fertility.

The financial importance of the kitchen garden is rarely appreciated, except by those who have all their vegetables to buy. Such a garden, even in its highest degree of perfection, may not *bring in* one cent, but it is difficult to estimate the dollars it *keeps in* the family purse. Its importance should be estimated from the amount *saved* and not from the amount *made* or *cleared*; and aside from the economy, pleasure and commendable pride that the owner derives from a well kept garden, he has the satisfaction of knowing that he is providing his family with fresh and wholesome food, lessening his drug and doctor's bills, and very probably prolonging the lives of those dependent upon him.

That truck gardening may be made profitable in Arkansas is made evident by the fact that throughout the greater part of the year the cities and towns within the State are supplied with many vegetables by rail or water from adjoining States. These come mainly from St. Louis, some from New Orleans. The produce that thus reaches the State is first shipped into these cities and reshipped. There is no reason why the State should not produce her own vegetables. On the other hand the truck farmers of the State have been rewarded with success in proportion with their intelligence, energy and knowledge of the business. Our favorable soil and climate, the increasing population of cities, and better transportation facilities have made possible the development of this industry, whether the product is intended for home or Northern markets. Few avocations require more intelligence and business tact than truck farming, and experience is necessary to its successful undertaking. The average man who for the first time engages in truck farming does not appreciate, or even recognize, the many essential details of the business, and fails in his undertaking and declares there is no money in it, or that soil or climate are unsuited, while, in the majority of cases, the real cause of failure was the man. The capital employed may not have been sufficient for the area cultivated; the soil may not have been gotten into condition for producing a paying crop; fertilization may have been inadequate, or cultivation improper or insufficient—or, it may be that the gardener was of the opinion that his successful culture of cotton and corn in the past insured his successful culture of potatoes and onions in the future. Though a truck farmer be well equipped for the undertaking, he is fortunate if he pays the expenses of the first year's operations.

The lack of appreciation of the advantages of our soil and climate, and ignorance of the requirements and hardiness of common plants, deprive many homes of fresh fall and winter vegetables. That a number of our most common vegetables will withstand repeated freezing is not generally understood, and the consequence is that no effort is made to grow them. The first killing frost of 1895 occurred on November 11. Up to that date the Station garden afforded thirty different kinds of vegetables, all growing in the open, without the slightest protection from cold. These were not merely growing, but available for table use. They were: bean, beet, cabbage, cauliflower, carrot, corn, cress, cucumber, celery, collard, eggplant, kale, lettuce, muskmelon, mustard, onion, okra, peas, pepper, potato, radish, shallot, salsify, spinach, squash, parsnip, parsley, tomato, turnip and garlic. On November 11, twelve of these were either killed or badly injured, viz: bean, cauliflower, corn, cucumber, eggplant, muskmelon, okra, peas, pepper, potato, squash and tomato—all tender plants. The remaining eighteen survived a temperature of 19° F., on December 6, with the single exception of radish. On January 4, the temperature was 14 degrees, the lowest for the winter of 1895-'96. Seventeen kinds survived this temperature, and on January 6, 1896, the writer enjoyed a vegetable dinner, embracing ten kinds, all of which were gathered that day from the open ground. Throughout the entire winter seventeen vegetables grew without very serious injury from cold, and were at all times available for table use. They were: beet, cabbage, carrot, celery, cress, collard, kale, lettuce, mustard, onion, shallot, salsify, spinach, parsnip, parsley, turnip and garlic, and survived 18 degrees below freezing point. While the temperature frequently goes lower than 14° F., it rarely occurs before Christmas, and one can always safely count on having ten or a dozen vegetables until the middle of December; while under favorable conditions several vegetables will survive a lower temperature than the above. On the other hand many of them may be killed by a higher temperature than 14° F., when the cold is preceded by several days of warm, moist, growing weather.

SOILS AND PREPARATION.

There is rarely an opportunity afforded for the selection of a site for a kitchen garden, as the residence is first located, and convenience requires that the garden be near at hand. A market garden should be as near transportation facilities as possible, and the land, if level, will better retain fertility and be more easily cultivated. A warm, sandy loam, well supplied with vegetable matter, is preferable. Sandy loam abounds in eastern, central and southern Arkansas, but for trucking are deficient in fertility. No matter how well suited these soils may be for growing good crops of cotton, corn or oats, the best results cannot be expected until after several years of heavy manuring and good culture. This applies more particularly to the upland soils. The alluvial deposits along the many streams contain a greater quantity of vegetable matter and are more fertile, and if thoroughly drained, are more readily converted into good soils for vegetables.

It is folly for one to expect to make a success of trucking in one or two years, and no one should undertake the business unless he is to remain in it for a number of years, and give it his closest attention and constant study. Having selected the soil he has much to do before planting. Stumps, roots, trash and the like must be burned or removed, and if level lowland it must be drained, whether it appears to need it or not, and underdraining should be practiced. If not level, the land must be terraced (See Bulletin No. 32), or rains will remove as much manure as the growing crops consume. Plowing must be deep and close, and manuring heavy and repeated. The causes of failure must be reduced as far as possible before they have an opportunity to operate, and the conditions securing success magnified.

MANURING AND FERTILIZING.

There is no one thing upon which the success of a truck garden so much depends as upon manures. They must be applied in quantities that would appear excessive to one engaged in any other branch of agriculture. The different vegetables require plant food in varying proportions, and a fertilizer suited to one may not contain the essential ingredients (ammonia, phosphoric acid and potash) in the proper proportion for another, and it is economy to have special mixtures for the particular vegetables grown. Celery requires a fertilizer containing 7 per cent of ammonia, 5 of available phosphoric acid and 8 of potash, while peas and beans require 3 per cent of ammonia and 7 per cent each of phosphoric acid and potash. Should the fertilizer containing the percentages of constituents suited to celery be applied to beans there would be a waste of 4 per cent of ammonia and a deficiency of 2 per cent of phosphoric acid. Should the bean fertilizer be applied to celery there would be a waste of 2 per cent of phosphoric acid and a deficiency of 4 per cent of ammonia. In either case the loss would amount to several dollars for 1 ton of fertilizer. Ammonia, phosphoric acid and potash occur in different soils in varying proportions and the fertilizer formula must be so modified as to correct the excess or deficiency, as may be indicated by experience. While for general gardening purposes stable and barnyard manures have no superiors, few gardeners are so situated that they can procure it in quantities to suit their needs. Such manures should be piled in a compact mass and occasionally turned over and well mixed that slow fermentation may be kept up. Chopping down the heap vertically will reduce the manure to a better condition for use by the plant and at the same time facilitate its distribution in the field. Where land is abundant or the supply of stable manure inadequate, green manuring and commercial fertilizers must be used to make up the deficiency. With an abundance of stable manure the separate fertilizing ingredients are frequently more profitably used with the manure than either alone, no matter how heavy the application may be. Under some circumstances and for certain crops it will be found that commercial fertilizers give better results and are more satisfactory than stable or cow manure. This has been notably the case at the Southern Branch Station with such crops as Irish potatoes, radishes and salsify. Until the soil has become well filled with vegetable matter there is no better or more economical way of rapidly increasing and at the same time balancing its fertility than by using crops of the cowpea or crimson clover for green manuring in connection with applications of phosphoric acid and potash.

Whether fertilizing materials are applied broadcast, in the drill, or in the hill they should be well incorporated with the soil before planting by the use of the harrow, plow or hoe. Unfermented manures should not be applied immediately before planting, but either composted or spread over the ground some time before it is to be occupied by the crop, otherwise it may affect the crop disastrously.

Soils need rotation of manures as well as of crops. A plot of land that has received continuous and heavy applications of stable manure will give greatly increased yields if commercial fertilizers are given it, with or without the continuance of the stable manure. On the other hand, the addition of stable manure will also greatly increase the yield when applied after continuous use of commercial fertilizers.

ROTATION OF CROPS.

Dr. Oemler, in "Truck Farming at the South," in discussing rotation of crops, says:

"Neither the areas nor the varieties of crops of the truck farmer are sufficient to enable him always to practice regular courses of rotation; nor should a lack of manure ever compel their strict observance, but he should aim:

"First—To have a crop which succeeds another as dissimilar in composition and the demand it makes upon the soil as possible.

"Second—Never to have plants of the same family succeed each other. For instance, melons should not follow cucumbers, tomatoes should not follow eggplants or Irish potatoes; beans should not succeed peas, or *vice versa*.

"Third—Tuberous plants should not be allowed to follow plants of the same character.

"Fourth—Roots should not succeed root crops, as turnips, beets, etc.

"Fifth—Deep or tap-rooted plants should succeed others of dissimilar growth.

"Sixth—To make the heaviest application of manure to such crops as require most, as cabbage, onions, etc., and have other crops succeed these requiring less, as tomatoes, eggplants, etc., so that the whole farm may be gradually brought to the same degree of fertility."

Other benefits of rotation are the destruction of noxious weeds and paracitic fungi and insects.

HOTBEDS.

Hotbeds are contrivances for advancing young plants with artificial heat while the outdoor temperature is yet too low for their successful growth, thus gaining from four to eight weeks in earliness. The cost of a hotbed is very little and it is surprising that they are not in more common

Google

use. When there is a choice of exposure select southeastern or southern with some protection on the north and northwest. This protection may consist of buildings, evergreen trees or some constructed wind-break, and at the same time have the bed fully exposed to the sun throughout the day. The bed should be convenient to water and to the person having it in charge.

The heat is supplied by fermenting horse dung which should be collected from the stable every few days and stored where it will keep dry or it may be taken directly from the stalls. A sufficient quantity must be on hand before the time for building the hotbed. The manure, which should have mixed with it one-third or one-half its quantity of leaves or short straw, is thrown into a well trodden conical heap. If the materials are dry, sprinkle over each layer with enough water to thoroughly moisten the mass. The heap will soon begin to "smoke," which indicates its heating. When this has been going on three or four days the whole pile must be chopped down and forked over thoroughly and again thrown into a conical heap. A few days later the chopping and forking is repeated and the manure is again piled and will be ready for the hotbed in ten or fifteen days from the time its preparation was begun.

The frame or box can be made by any one gifted with the use of saw and hammer, and consists of a box 16 or 18 inches high at the north side and 12 inches on the south, the ends conforming to the pitch. The width is 6 feet from outside to outside, and may be of any length desired to accommodate any number of sash. At intervals of 3 feet 2-inch strips should be let into sides flush with the upper edges for the sash to rest on and to prevent the sides from spreading. These strips are 6 feet long and extend across the frame. The sash, ready glazed, cost from $1.25 to $1.50, and may be procured of firms handling sash, doors, etc. Remove 20 or 30 inches of earth from within the frame, filling this space with the manure well tramped in. For several days immediately after the manure is put in it should be covered with about an inch of soil and the sash put on. The temperature will rise rapidly and in a day or two will reach 100 degrees or more. When this high temperature has subsided to about 90 degrees the soil covering the manure must be increased to 4 or 6 inches. The soil should be of even texture and very fertile. The hotbed is now ready for the seed, which are planted in rows from 2 to 4 inches apart, and running across the hotbed, or north and south. The temperature in the bed must be watched closely and not allowed to run too high or above 95 degrees. About 80 or 85 degrees is a good temperature to maintain, and is regulated by raising the upper ends of the sash. Except in extreme cold weather fresh air should be daily admitted into the bed, and at no time should the plants either suffer from too much or from too little water. In cold weather the water should be heated to about the temperature of the hotbed, or it will injure the plants. A thermometer should be kept in the bed that the temperature may be accurately regulated, as either extreme is harmful. On warm, cloudless days it will frequently be necessary to remove every other sash.

If the soil upon which the hotbed is to be built is not well drained or is liable to become saturated in wet weather, no excavation should be made, but the manure spread on the surface of the earth in a flat top heap a foot wider and longer than the frame. The frame is simply set on top of this heap, the soil put in and earth heaped against the sides and ends and well packed down to prevent the escape of heat.

Hotbeds may also be heated by flues or escape steam. An abundance of leaves or straw should be kept convenient that the hotbeds may be covered in very cold weather.

COLD FRAMES.

The construction of cold frames is the same as hotbeds, but no fermenting manures are used. The soil should be 6 or 8 inches deep and made very fertile with manures or fertilizers. If weed seed are in the soil they should be made to sprout and be destroyed before the seed are planted. This is done by preparing the frame two or three weeks ahead of time and keeping the soil stirred. Cloth frames may be used to cover either hotbeds or cold frames in lieu of sash. The latter, however, will maintain the higher temperature. Cold frames will be found serviceable for hardening off hotbed or greenhouse plants in the early spring and for transplanting seedlings to increase their root growth and produce more stocky and hardy plants; or, by shading in summer with cloth frames or brush elevated 4 or 5 feet, plants may be started for the fall crops.

SHALLOW BOXES FOR SEEDLINGS.

For growing young plants to be transplanted shallow boxes or trays will be found quite serviceable. They are made of boards one-half inch thick and may be 12 to 18 inches wide by 20 to 30 inches long and 2 or 3 inches deep and filled with rich soil. Cabbage, cauliflower, tomato, lettuce, eggplant, pepper, celery, etc., may be planted in them. The boxes may be removed to shade in hot weather and in the absence of hotbeds and cold frames may be kept during cold weather in the dwelling. If the young plants become crowded they may be transplanted to other boxes.

PLANT BEDS.

The soil for plant beds should be moderately fertile to begin with and further enriched by digging in wellrotted manure and fertilizers. If intended for early spring plants the exposure should be southern, but for fall and winter plants a northern slope is better. The beds should be chopped or plowed several times to remove all trash and to reduce the soil to a fine and mellow condition. They are better if prepared three or four weeks before needed and the surface frequently stirred in the meanwhile to induce the germination of seed of such noxious plants as may be troublesome. Plant beds are particularly serviceable for sowing the seed of tobacco and celery, and for the fall crops of cabbage, cauliflower, lettuce, etc. The beds should be so situated and arranged that shading may be resorted to when necessary. Shade is generally furnished by cloth frames or brush arbors, and should be elevated about 4 feet above the bed to insure free circulation of air. If too close to the plants they will become long-shanked or spindling. The bed should be convenient to water, as plants intended for fall vegetables are planted in hot weather, and will not succeed without liberal watering. The beds should have good drainage, and a light ditch on the upper side will prevent rains washing across them.

SEED.

Good crops are grown from good seed, and the gardener cannot run the risk of failure by using doubtful seed. There are but few vegetable seed that the gardener can afford to grow for his own use. In fact but few gardeners are versed in the art of the growth and selection of seed. The reliable and up-to-date seedsmen are, as a rule, as careful in the selection and breeding of the different varieties of cultivated plants as are the breeders of live stock. Considerable knowledge and skill are neccessary for the successful improvement and perpetuation of the better qualities of a variety, and the seedsmen employ experts to grow many of their seed, and constantly endeavor to evolve something better by selection and cross-breeding. Within the past few years varieties of very near all of our common vegetables and farm crops have been improved or introduced that possess qualities superior to the varieties considered best a few years ago. The average gardener or farmer does not fully understand either the principle or the practice of growing good seed, hence much of the common complaint of seed "running out." Experience has taught that certain seed grown in certain localities produce well, and *vice versa.* Some seed produce better when grown in the latitude or altitude in which they are to be planted, while others are better grown further north or further south. Watermelon, muskmelon, cucumber, squash, corn, okra, Lima bean, pepper, eggplant and tomato seed should be grown under climatic conditions as nearly similar as possible to the condition prevailing where the seed are to be planted. On the other hand cabbage, cauliflower, beet, carrot, turnip, parsnip, bean, pea and lettuce produce more satisfactory results when the seed are grown further north, while French grown radish seed are considered superior to those grown elsewhere. Reliable seedsmen now recognize these and other important facts, and grow their seed and fill their orders accordingly. Practically all of our cultivated plants have been improved or bred up to form and substance and other desirable qualities which are superior to those possessed originally by the plants, and they have a natural tendency to revert to their original character, hence the greater care necessary for the continuation of these artificial or evolved characteristics, and for their improvement. Again, the cross-fertilization or "mixing" of plants will take place at considerable distance through the influence of insects and winds, and great care is necessary in planting related varieties to have them sufficiently removed from each other to prevent this crossing, or hybridization, as the case may be. Many seedsmen now take great pride in their "thoroughbred" or "pedigree" seed. These pedigree seed are about as important to the gardener as the pedigree cow to the dairyman.

SEED SOWING.

Unless certain of the germinating power of seed, they should be tested before planted. It is very provoking and expensive to make elaborate preparation, and after careful planting find that they do not germinate when it is too late to secure another supply and plant again. If 100 seed are counted and planted in a shallow box and kept in the proper temperature, it is no difficult matter to ascertain to what extent they may be depended upon.

It is of the greatest importance to the gardener that the proper preparation of the soil be made for the reception of the seed. Manuring, plowing and harrowing should be through with before planting time. More failures result from improper planting than from inferior seed. The seed should be put in the ground when it is neither too dry nor too wet. An important operation in connection with seed sowing, and one often neglected, is the rolling or firming of the soil after the seed have been covered. The best implement for this purpose is a good hand roller, though the back of either a spade or hoe may be used, or it may be done with the foot. Seed thus firmed will often vegetate or appear above ground two or four days earlier in very loose soil than those left loosely covered. Garden seed sown in drills will almost invariably give better results than those sown broadcast, if properly thinned and cultivated. A good seed drill will save both seed and labor, and should be used when seed are to be sown in quantity. Drills may be procured that open, sow, cover and roll, and no market gardener can afford to be without one. The depth to which seed should be covered varies with the different classes of seed, the character of the soil, the quantity of moisture present, and the season of the year. In light sandy soils, seed require deeper covering than in stiff, heavy or clayey soils. The dryer the soil, the deeper they should be put in. They should be planted deeper in warm than in cool weather. The size of the seed to a great extent controls the depth of planting. If the soil is in perfect condition, the covering should be two or three times greater than the thickness of the seed, but deeper if in very light soil, and not so deep if in heavy. Beans require light covering, however; particularly Lima beans, while peas may be planted 3 or 4 inches in very light soil, and 5 would not be too deep.

VEGETABLE CULTURE IN ARKANSAS.

It is our purpose to give, under this caption, special directions for the culture of a number of vegetables adapted to the soil and climate of the State. The dates given for any special work refer to the southern third of the State. The advent of spring is from one to two weeks later for the middle third, and from twenty to thirty days later for the northern third, supposing the State to be divided into three equal parts by lines running east and west, and the approach of winter correspondingly earlier.

ASPARAGUS.

This vegetable, like celery, is considered a luxury, because the majority of persons who would like to grow it have an idea that it is very difficult and expensive to successfully cultivate. The markets are never glutted with asparagus, and few crops are more profitable to the gardener, while 75 or 100 plants will supply a large family.

GROWING THE YOUNG PLANTS.

The plants are grown from seed sown in February in rows 12 or 18 inches apart and are covered about 1 inch in depth. To produce in one year strong plants large enough for permanent setting, the soil must be made mellow and fertile and the plants well cultivated throughout the year. Strong plants are essential to good results, and the seedlings must be so thinned that each plant will have ample room for development. If the seedbeds are not kept free from weeds and well cultivated the plants will become stunted. If 1-year-old plants are well grown they are better than 2-year-olds for setting in permanent rows. One or 2-year-old plants may be had of nurserymen or seedsmen for from $4 to $8 per 1,000. The seed cost from 75 cents to $1.26 per pound, according to the variety, and a pound of seed should produce 4,000 plants. The leading varieties are sold under the names of Barr's Mammoth Columbia Palmetto and Carnover Colossal.

TRANSPLANTING.

With good treatment asparagus plants may be expected to give good returns for twenty-five years, and it necessarily follows that the preparation of the soil must be the best and the manuring heavy, and very heavy if the largest shoots are expected. A fertile sandy soil that has been under high cultivation for several years would be a good selection, and a southern or southeastern exposure is preferred. Lay off the rows 4 or 5 feet apart and throw out the soil both ways with a turning plow to the depth of 10 inches, making a furrow about a foot wide. Distribute a heavy dressing of manure in this furrow and thoroughly incorporate by running several furrows with a narrow plow. Raw bone is an excellent material to apply in the drill, as it is of slow decomposition. The plants are set about 18 inches apart and the roots spread in their natural position, with the crown 3 or 4 inches beneath the surface of the soil. When the plants are first put out do not cover them more than an inch, for fear the first young shoots may not be able to push through a deeper covering, but gradually fill in as stronger growth progresses until the furrow is completely filled. Thorough cultivation is essential to strong growth. The shoots should never be cut the first year after transplanting, and rarely the second, as early cutting seriously weakens the roots. Cutting should be delayed until the third year, and not be too closely done then. Do not let the plants mature seed, for if allowed to do so they will fall to the ground and produce new plants which will greatly injure the old. Each year before the young shoots appear a heavy dressing of manure will be beneficial, and the manure should be supplemented with about 500 pounds of kainite per acre very early in the spring. This will supply both potash and salt.

Knives made especially for cutting asparagus are on the market, but an ordinary case knife will do. The cutting should be done with the greatest care or many young shoots will be destroyed. The knife should be inserted into the soil to the proper depth and near the shoot to be cut. With the handle held firmly the knife is twisted toward the shoot, thus cutting it with but little danger to young shoots that are just beginning to grow.

While many markets demand white or bleached asparagus the green shoots are more tender and better flavored.

Asparagus is marketed in bunches 3 or 4 inches in diameter and 6 or 8 inches long. These bunches should be of uniform size, and to secure this, implements called "bunchers" are used, several kinds of which are on the market. The bunches are tied with raffia, bast or twine.

BUSH OR SNAP BEANS.

The snap bean is a favorite crop with both the market and the private gardener on account of the ease with which they are grown and the short time they occupy the ground. Beans of all kinds do better on a light sandy loam, well drained and with a warm exposure. This is particularly true with the extra early crop. The bean, being a leguminous plant, does not require a fertilizer rich in nitrogen, but needs both phosphoric acid and potash in liberal quantities to secure a full yield. Beans and peas will yield profitable crops on soils not sufficiently fertile to grow profitably other garden truck, but on the other hand they respond liberally to good feeding. If the soil is well supplied with nitrogen none need be applied, but only potash and phosphoric acid. The rows are made 2 or 2½ feet apart and one or two beans dropped every 2 or 3 inches if cultivation is to be done exclusively with the plow. If the hoe is to be used, four or six beans should be dropped just far enough apart in the drill to admit of the free use of the hoe between the hills. The growth and maturity of the bush bean is so rapid that the crop is generally gathered before weeds have time to make a good start, and there is frequently no need of using the hoe, which is an expensive implement when the plow can be made to take its place. Two or three plowings should make the crop, but shallow cultivation had better be continued as long as the vines will admit. The spring crops should be planted in succession, beginning about the middle of March in the southern part of the State, and additional plantings being made at intervals of two or three weeks. The fall crop is planted from the middle of August to the middle of September. The depth of planting depends upon the soil and the season. The fall crops should be planted 3 or 4 inches deep, while 1 or 2 inches is sufficient depth for the early spring crop. If the soil is stiff and heavy, with an inclination to bake, they should not be put in so deep as in a mellow, sandy soil.

The market beans are gathered when about half grown, or before the seed begin to bulge the pods. Do not gather when wet with either dew or rain, and use both hands, one to hold the vine and the other to pull the pods, or the plants may be injured.

Beans are generally shipped in bushel crates, the pods being placed parallel with each other and firmly pressed down, that the shrinkage may be counteracted. If allowed to become slightly wilted before packing they pack more snugly and are less liable to become bruised or broken. When the crop is gathered the vines may be cut for stock or plowed under to improve the soil.

About two bushels are required to plant an acre. Of the twenty or thirty varieties tested at Camden the Mohawk has been the most satisfactory early variety, and the Valentine, Golden Wax, Detroit Rustproof Wax, Thorburn's Prolific Market, and Keeney's Rustless Golden Wax are highly recommended.

POLE BEANS.

Pole beans are later in maturing than the bush varieties, but continue in bearing much longer and stand the hot months better. They require a more fertile soil than bush beans and are given greater distance between the hills. For summer and fall they are a safer crop than the bush, both for the market and home use. They may be planted in checks 4x4 feet. To secure the poles against being blown down, four of them may be tied securely together at their tops, with the butt ends of each in the ground near a hill, thus forming a pyramid. The poles are 6 or 7 feet long. In the absence of poles posts may be set in the rows at intervals of 20 feet, having the end posts securely braced. Two wires are then stretched along the posts, one at the top and one a foot above the ground. The top wire should have a support between each post to prevent sagging. Strings are tied, extending from one wire to the other, for the vines to climb on. With this trellis the hills may be 12 or 18 inches in the row, and cultivation may be more thorough than when poles are used. The best varieties are Southern Prolific, Lazy Wife and Creaseback or Fat Horse.

LIMA BEANS.

The Lima or butter beans are not cultivated to the extent merited by their qualities and easy growth. Whether eaten green or ripe they furnish a nutritious and excellent dish. Their easy preservation makes them particularly valuable as a winter dish. None of the dwarf or bush varieties tested through three years at Camden have succeeded sufficiently to justify planting them, but the pole varieties have given good results. The Sewee and Willow-Leaf have been prolific, stand drouth remarkably well and bear until killed by frost. Their cultivation is the same as for pole beans, but do not require to be planted so deep.

BEETS.

Beets delight in a deep, loose and well drained soil. The young plants are quite delicate and require a well prepared seedbed and careful treatment during the early growth. Beets, like many other vegetables, do not do well in fresh soil, but succeed better where liberal manuring and thorough tillage have been practiced for several years. Fresh or coarse manures should be avoided, as poorly shaped roots will result from their use. The beet is quite hardy, and unless quite young, will stand several degrees of freezing. Seed planted in September will very probably furnish 2 or 4-inch roots in February and March. They have been successfully grown two of the past three winters at Camden without injury from cold. The spring planting is made about the middle of February, but seed kept on hand in case the early planting may be killed. In the home garden the rows may be 12 or 18 inches apart, but for market purposes sufficiently wide to admit of cultivation with the plow. Beets respond liberally to heavy applications of fertilizers.

Manures or fertilizers should be uniformly distributed, deeply and thoroughly incorporated with the soil. If the seed are planted with a drill the work is more quickly and easily done and cultivation is facilitated. Five pounds of seed will sow an acre. The young plants are thinned to 4 inches in the drill when the size of a pencil. Beets transplant readily, and missing places may thus be filled. A long dibber should be used in transplanting that the roots may be put in the soil straight. Frequent cultivation is essential to quick growth, and all weeds should be kept down. Two or three plowings and the same number of hoeings will make the crop. Beets are marketed before grown and when only 3 or 4 inches in diameter. The shipping is done in ventilated barrels and crates, closely packed, with all leaves cut off to within 2 or 3 inches of the root. The leaves furnish excellent food for stock.

The earliest variety is the Bassano, but its light color detracts from its market value. Lentz, Eclipse, Egyptian and Blood Turnip are good market varieties.

SPRING CABBAGE.

More than half of the cabbage consumed in the State are shipped in from Northern markets. Some come from further South in early spring. The State can easily grow its own supply and sell the spring crop in Northern markets at a rich profit.

SOWING THE SEED.

When the young plants are to be wintered over the seed for the spring crop should be sown about October 1, that the plants may be set in the permanent rows in November. Other sowings ten days earlier and ten days later will be safer as the weather at this season of the year is uncertain and it is more profitable to lose a few ounces of seed than to lose a whole crop of cabbage. If planted too early drouth may so check the young plants as to cause them to run to seed in the spring instead of heading. If planted too late they may be too young and tender to survive the first hard freeze. To guard against a loss of plants by severe cold in January or February another sowing of seed had better be made in cold frames about December 1, and still another in hotbeds or greenhouse about January 1. These precautions will secure against all possible loss of a crop, but are not always necessary. The surplus plants will find ready sale. The planting of October 1 should be made on medium fertile soil, without manure or fertilizer, that no check in the growth of the plants will be occasioned by transplanting to highly manured permanent rows, as may be the case with plants made to grow too rapidly before the final transplanting. Neither should the plants be allowed to grow too thickly in the seedbed but given ample room to secure stocky growth. The seedbeds should be about 4 feet wide and the seed sown thinly in rows running across the bed. The rows should not be closer than 5 inches, and 6 or 8 inches would be a safer distance. The beds should be about level, but elevated slightly to insure proper drainage, and are better prepared a few weeks before the seed are to be sown and kept cultivated in the meanwhile.

The cold frames and hotbeds may be sown broadcast or in rows 3 or 4 inches apart. If sown broadcast the young plants must be transplanted when the third leaf appears to other beds or frames and set 3x3 or 4x4 inches where they are to remain until taken to the field. It will pay to transplant all seedling cabbage, for the increased vigor of transplanted plants is very marked. Cold frame and hotbed plants require close attention. Neither too much nor too little water should be given, and the covering, whether sash, cloth, mats or boards, should never be left over the plants except when there is danger of freezing weather. An abundance of fresh air and sunshine is essential to their healthful growth. Always use an abundance of seed, but thin out carefully and remove all weak or imperfect plants. The good plants removed by thinning may be transplanted to another bed or frame or thrown away. One good plant is better than two poor ones. One ounce of seed should produce from 1,500 to 2,500 plants. The seed should be covered about 1 inch if planted in October, and about half that depth in December. As soon as the seed show above ground sprinkle tobacco dust over the bed and repeat about once a week to keep off insects. Too much water will cause the young plants to "damp off" or die from the effects of a fungous disease. After the seed are sown should a heavy rain occur before germination, the soil should be lightly stirred as soon as in condition to prevent baking.

SOIL.

The cabbage is a gross feeding plant and requires a rich, deep and mellow soil heavily manured to produce the best crops. A mellow loam with clay subsoil is preferable, but sandy loam will give a good crop. Good drainage is essential, and particularly to the early spring crop. Heavy lowlands, no matter how fertile, rarely produce a good early crop, nor is new ground good. The average garden soil that for some years has been in a high state of cultivation will produce a good crop. A slight northern exposure will frequently give better results for the extra early crop than a southern, as the former is not subject to such marked changes of temperature. Deep and thorough preparation is as essential as an abundance of plant food and good cultivation. Rotation is necessary, and cabbage should not occupy the same soil twice in succession, nor should any plant of close botanical relation be grown on the soil in the meanwhile, such as cauliflower, mustard, kale, etc.

TRANSPLANTING.

If the plants are grown in hotbed or greenhouse it is necessary that they be hardened off or accustomed to cold temperature and full exposure before they are set in the field. Before drawing the plants the soil around them should be thoroughly soaked with water that more soil may adhere to the roots and fewer roots be broken. As soon after the plants are drawn as convenience will admit, they should be put out. Should it be necessary that the plants remain out of the ground any length of time they should be placed so that their roots will be in watery mud to prevent wilting. If possible transplanting should be done late in the afternoon or on a cloudy day. They should be set in the ground so that the bud will be just at the surface with all the stem covered. Press the soil firmly around the plant—so firmly that it will break off rather than be pulled up. The foot is the best and quickest implement that can be used for firming the soil around the plant. The rows should be from 2½ to 4 feet and the plants from 1½ to 3 feet in the row, the distance depending upon the variety of cabbage. The small, early, upright growing varieties admitting of closer setting than the large, late varieties. The small and large late varieties may alternate in the rows, as the former come off several weeks earlier than the latter. It is rarely necessary to water the early crop when they are transplanted, but when necessary it is done as directed for the fall crop.

CULTIVATION.

No plant will give better returns for frequent and thorough cultivation after growth has begun in February. Before then very little, if any cultivation is necessary. The first plowing in February should be moderately deep, but afterwards all plowing is best done with the heel sweep, and this plow should be run as soon after each rain as the ground is in condition to be worked. When the plants are yet young a cultivator may be used, but after they have attained some size no implement will do better or more thorough work than the heel sweep. One or two hoeings may be necessary, but may be dispensed with if the plants are in checks and plowed both ways. At no time must the soil become baked, but always kept loose and mellow by frequent stirring. As cultivation progresses a little soil may be worked to the plants.

For earliness, uniformity of size and sure heading the Early Jersey Wakefield stands at the head of the list when the seed are of a good strain and pure, and is the most popular variety for early market. Other varieties that have done well for extra early growth are: Early Cannonball, Extra Early Express and Winningstadt. For second early Early Summer, Brunswick, Premium Flat Dutch and Drumhead are reliable.

SUMMER CABBAGE.

Seed for the summer crop are planted in March and April and transplanted when large enough. This crop is marketed before the Northern crop arrives and after the Southern spring crop is exhausted. They do not bring so good a price as the early crop, but cost much less. It is an uncertain crop, however, and liable to rot and to damage from insects.

FALL AND WINTER CABBAGE.

The most common cause of failures to grow fall and winter cabbage is that the seed are planted too early, thus prolonging the period from seed to maturity and making the plants more liable to be destroyed by excessive heat, drouth, insects, etc. The seed are sown in the spring, and should the plants survive at all the fall finds them in so stunted and dwarfed a condition that they can afford but little more than a bunch of greens at the top of a tall stalk.

The seed for the early fall crop should be planted not earlier than June 15, and for the winter crop about August 1. The seedbed for the June sowing should be only medium in fertility, while for the August planting the bed cannot be made too rich, as the plants must be made to grow rapidly. The seedbeds are better prepared if burned over after the manner of burning tobacco beds. The soil must be worked fine and mellow and the seed covered about three-fourths of an inch. At no time must the bed become dry, and a covering of some sort is necessary to protect them from the hot sun. This shade may consist of cloth frames, leafy brush or old boards, and must be elevated 4 feet above the bed to give free circulation of air and the benefits of the early and late sun. The seed should be sown thinly in rows about 6 inches apart, and the soil between the rows stirred frequently. It will be necessary to water the plants quite frequently, and this should always be done late in the afternoon. An occasional dusting with air-slacked lime and tobacco dust will keep off the flea beetle, and Paris green in solution will destroy the cabbage caterpillar or "green worm." When large enough the plants are set in their permanent rows and liberally watered. In transplanting the leaves should be gathered in a funnel shape around the bud and the plants set so deep that the bud will be just at the surface of the ground or a little below. The leaves will protect the bud from the sun, and to some extent from cutworms. In watering while transplanting do not wet the surface of the soil but pour the water into the hole opened for the plant and cover over with loose, unmoistened earth. Simply watering the surface of the soil after the plants are set will frequently do more harm than good, and particularly if the soil is dry.

The soil should not only be naturally rich, but the crop preceding the cabbage should be heavily manured and commercial fertilizers will pay when given direct to the crop. The soil should be more moist naturally and not so sandy as for the spring crop. That the plants may be kept growing regularly and rapidly frequent and thorough cultivation must be given and one or two top dressings of nitrate of soda and muriate of potash will hasten growth. The fall crop should be well headed by October 15 or November 1, and the winter crop by December 15. As a rule these crops of cabbage will keep in the field without protection, but to be secure against severe cold the roots on the south side of the plants are cut with a plow or spade and the cabbage bent down, where they grow, toward the north and the stalks and base of the heads covered over with earth. Neither cabbage nor any other plant should be disturbed while frozen.

Good varieties for the fall crop are Brunswick, Flat Dutch, Improved Early Summer, Harvest Home and Louisville Drumhead.

MARKETING.

The harvesting of the spring crop should begin as soon as the heads have become hard. A head weighing 3 or 4 pounds in April will sell for as much as a 6 or 8 pound head in May or June. A sharp hatchet is the proper tool for cutting cabbage. A few of the outer leaves should be left for protection to the head and for better packing, but the stalk should be cut close to these outer leaves. Cabbage are usually shipped in crates and well ventilated barrels. The barrels are covered with bagging secured by the top hoop. Cabbage should be perfectly dry when packed and if slightly wilted the packing may be better done. Each head should-be firmly pressed down to prevent shrinkage in transit, and only heads as near as possible the same size should be placed in the same package, and the number of heads marked on each barrel or crate.

CAULIFLOWER.

The treatment of cauliflower is very near the same as that for cabbage, but inland they do not reach that degree of perfection attained near the sea coast. They require a richer soil and more water than cabbage, and are more susceptible to extremes of temperature. It is rarely possible in our climate to grow a fall crop, but with proper conditions and close attention the spring crop may be grown successfully. The seed should be sown in cold frames or hotbeds in December and January and kept at all times in a healthy condition. When the plants are large enough to handle, transplant to other frames or beds, and give ample room to prevent crowding. They may first be transplanted to 2-inch pots, and later to 3-inch and 4-inch, and finally to 6-inch pots, from which they are set in the field. Before transferred to the field, the sash should be left off whenever the temperature is a few degrees above freezing or warmer, to prevent their becoming too tender and succulent, but avoid sudden changes of whatever kind. Should the plants receive a check in their growth at any time, only abortive heads or "buttons" will be produced. Should the plants threaten to become too crowded before they can safely be set in the open ground, they should be again transplanted further apart. It is safest, however, to have the plants at sufficient distance so as not to require the second transplanting before they go to their permanent rows. It is advisable to make two or three sowings of seed a week or ten days apart, to be sure that the plants are of the proper size and condition when the weather permits the final setting. The rows are 3 or 3½ feet and the plants 2 or 2½ feet in the row. The field culture is the same as for cabbage. When the heads are about 2 inches in diameter, the leaves should be brought together and tied, or pinned with a slender stick, so as to thoroughly protect from the sun, that the heads may be bleached. The heads are cut when they have about attained their full size, and before they begin to crack. Enough stalk should be left with the heads to have them well protected with leaves and prevent bruising. Cauliflowers are shipped either in barrels or crates, each head wrapped in thin paper and carefully pressed down. They should not be packed until thoroughly dry. One difficulty in the way of growing cauliflower is the price of the seed, which ranges from $25 to $50 per pound, and sometimes as high as $75. An ounce should produce 2,000 good plants. Early Snowball and Burpee's Best Early very closely resemble each other, and are the only varieties that have been planted at Camden with success, except the Early Erfart, which is decidedly inferior to the first two. None of the large late varieties have been successfully grown.

COLLARDS.

While the collard is not deemed an aristocratic vegetable, it is found through the winter in more Southern gardens than any other vegetable, with the possible exception of the turnip. It will endure a very low degree of cold, and its table qualities are greatly improved by freezing. Its treatment should be identical with fall and winter cabbage. The seed are generally planted so early in the spring that when winter comes the bare stalks are several feet tall, with a small cluster of leaves at the top. If the seed are sown between June 15 and August 1, a much superior crop is secured with less labor, less injury from drouth and insects and without the unsightly stem. The variety known as the White Georgia is far superior to old Blue Georgia, and is rapidly superseding it.

CARROT.

This vegetable should be planted in a light, deeply worked and fertile soil, and one that has been manured well for the previous crop rather than have the manure applied directly. Carrots will stand quite a low temperature and may be planted either in the late fall or early spring, the latter being preferable. The early spring sowing should be made between February 15 and March 15. For garden culture the rows may be 12 or 18 inches apart; but when grown on a large scale, they should be wide enough to admit of plow culture. The young plants are small and grow off slowly, and the earlier the seed can be safely planted the less will be the labor of keeping down weeds. They are thinned to 2 or 3 inches in the row and cultivated like beets. Aside from their value as a table vegetable carrots are excellent for stock, and particularly for milch cows. Carrots will keep well where they grew if two furrows are thrown over the row about December 1, but may be put up as is the practice for sweet potatoes. With favorable moisture and temperature the early varieties may be planted September 1, and attain market size in December.

Extra Early Forcing, Early Scarlet Horn, and Half Long French Scarlet are good early varieties. Later and larger varieties are Improved Long Orange, Long Red and Danvers. These are good varieties for stock.

CELERY.

There are few, if any, crops grown that cost so much to produce a first-class article as does celery, but the profits are large. Celery requires intelligent and close attention, rich, suitable soil and an apparently excessive quantity of manure. Celery is a native of cool climates and moist, if not wet, land, and it is useless to attempt to raise it in Arkansas during the hot and often dry summer months. The seed sowing and final transplanting must be so regulated that the crop will mature in the late fall or early winter. The rich lowlands that border streams furnish the best soil, but even these fertile bottom lands need a few years of thorough cultivation and heavy manuring, with additional heavy applications of plant food before the plants are transplanted. The area intended for celery may grow a crop of Irish potatoes in the spring, cowpeas for hay in summer and the celery put out in August and September.

GROWING THE YOUNG PLANTS.

Preparation of the bed for growing celery plants should begin early in the spring, and be kept cultivated clean and all weed seed be induced to germinate and be destroyed before the celery seed is sown, but a better plan than this is to burn the bed as tobacco beds are burned. The bed must be heavily manured and worked until in as fine and uniform texture as possible, level and smooth. An additional area of bed should also be prepared to receive the plants when ready for the first transplanting. The seed should not be sown earlier than the middle of May in South Arkansas. Successive sowings may be made two weeks and a month later for the late winter crop. The rows are marked off across the bed and 6 inches wide to facilitate cultivation. The bed should be from 4 to 6 feet wide, with sufficient length to grow the desired number of plants. For marking the rows a board 6 inches wide and of a length equal to the width of the bed will be serviceable. Begin at one end, with the board across the bed, and open the rows with a small stick, using the edge of the board to get them straight. The operator stands on the board and as he opens a row plants it by sowing about four or six seed to the inch. The board is then turned over or moved forward 6 inches and another row opened and sown; this is repeated to the end of the bed. The seed are covered by beating over the bed with the back of a spade or by rolling with a light garden roller. The rows should not be opened deeper than one-fourth or one-third of an inch. As soon as planted the bed should be covered over with old sacks, matting or leafy brush, to keep the soil moist, as the least drying of the soil may destroy the seed when germinating. As soon as germination fairly begins the covering must be gradually removed, that the plants by degrees become accustomed to their new surroundings. This is best done by constructing an arbor as directed for fall and winter cabbage, as the young celery plant will be benefited by a little shade through the summer. Before the final transplanting the shade must be entirely removed, part at a time, to thoroughly accustom the plant to full exposure to the sun. While the plants are in the beds cultivation should be frequent, not only to kill all weeds, but to keep the ground loose and mellow, that the best quality of plant may be grown. It will be necessary to water the bed liberally and frequently, and if growth is not so rapid as desired a little liquid manure will be beneficial.

TRANSPLANTING.

To secure strong, well-rooted celery plants the seedlings when about an inch high, are transplanted to other beds and set 1 or 2 inches apart in rows 4 or 5 inches wide. The soil of this bed should be highly fertile—but this is true of all soil intended for this crop. The plants will be improved by cutting away about two-thirds of the tops should the growth be less stocky than desired. The final transplanting should not, in South Arkansas, be made before August 15—about September 1 is a good time. The old way of growing celery by setting in deep trenches has been superseded by methods more economical, and which produce better celery. A common method is to set the plants in rows 3 or 4 feet apart, the plants being from 4 to 8 inches in the row, the distance depending upon the variety. The rows are thrown out with plow, manure put down and thoroughly incorporated and the soil plowed back, forming a slight ridge. The rows are then rolled or raked level, and marked with a line that the plants may be set straight to facilitate future work. It may be better to shorten both the tops and the roots, should the latter be too long. The earth must be pressed firmly to the roots with the foot after setting the plants. Unless the soil is quite moist the plants must be liberally watered. The transplanting will be more successfully done on cloudy days or late in the afternoon. If the plants have been exposed to the sun continuously for a week or two before transplanted there will be less trouble from wilting. Should shading be necessary immediately after setting in the field, which is more frequently the case than otherwise, plank may be placed on the south side of the rows leaning them toward the row and secured with stakes driven firmly in the ground. The plank should be removed in the afternoon and returned in the morning so as to give the plants the benefit of the late and early sun and thus gradually inure them to their surroundings. The plants in the field require constant cultivation until earthing begins, not only to suppress weed growth, but to keep the soil in good condition that rapid growth may be secured. Professor Massey, of the North Carolina Station, recommends the following method: "The great difficulty here in some winters is to keep it from growing all winter and running to seed. We therefore plant the celery in beds, because it is more economical of labor to earth up a bed than to earth up the same number of plants in single rows, and also because the single rows, earthed up, leave the sides of the narrow banks exposed to the sun, and warm up to such an extent that the celery is kept growing when we want it to become nearly dormant. We can accomplish this better in a broad, flat-topped bed, than we can in single rows. Planted as we plant celery, an acre will contain about 37,000 plants. We set the beds 5 feet wide and of any convenient length, and where a number are planted a space of 8 feet is left between the beds for the purpose of getting soil for earthing. The beds are never sunk, but planted on the surface. The rows run crosswise of the beds, and are 1 foot apart, with eleven plants in each row, thus making them 6 inches apart in the row."

Another method consists in setting the plants so close that they exclude the light and are practically self-blanching. It is necessary that only the self-blanching varieties be used. As the plants are about five or six times thicker than when planted in wide rows there must be a corresponding increase in the manure and moisture applied. After the plants have completely shaded themselves with their tops no further work is necessary except to earth up the outside rows. The plants when set should be of uniform vigor and size and there should be no missing places.

HANDLING AND EARTHING.

The outer leaves of celery have a tendency to spread flat upon the ground rather than grow upright, the position they must be in for the proper blanching. To remedy this the plants are subjected to what is called handling. This consists in bringing the leaves to an upright position and firmly pressing enough loose earth against the plants to hold them in this position. Before this is done the rows should be well cultivated that the soil pressed to the plants may be fine and loose and more easily manipulated. The leaves may be brought together and held with one hand while the other draws the soil in position and firms it. This should be done in October and no more soil used than enough to well hold the plants in the upright position. To facilitate this work one or more long cords with short stakes at each end will be found convenient. An ordinary garden line will answer. One stake is driven in the ground in line with the row and a short distance from the end. The cord is then wound once around each plant on to the other end of the row and the other stake driven in. The leaves are thus brought together and earth is drawn up and firmly packed around the plants in quantity sufficient to keep the plants in the upright position. The cord is then unwound and is ready to be used on another row. The leaves should be closely brought together that no earth will find its way into the heart of the plant. The final earthing up is done about the middle of November when earth is brought up to the plants until only the tips of the leaves are exposed. As these grow out more earth is added until the middle of December when the rows are completely covered and may so remain until the celery is wanted. Celery will endure quite a low temperature and will keep well in the rows if properly earthed up. Plank a foot wide are sometimes used for blanching, but if used alone before winter the plants become too warm from the sun and are injured. They may be used, however, with earth to advantage, and less earth is required than when used alone. When thus used the boards are set on edge a few inches from the plant and on either side and the space between filled with loose earth. More than one plank is necessary for the larger varieties, as they grow much more than a foot high.

VARIETIES.

The dwarf varieties do not succeed so well in the South as do the larger ones. Giant Pascal is by many considered the best for the South, though Golden Heart, Perfection Hartwell, Giant White Solid, Golden Self-Blanching and Pink Plume are good.

MARKETING.

There is great demand for celery in Southern markets, which are now largely supplied from the North and West. Southern grown celery will always find a ready market and good prices.

In preparing for market the stalks are washed and the outer leaves removed. It is then tied in bunches of uniform size. It is important that it be placed on the market while fresh and crisp.

CANTALOUPES AND CUCUMBERS.

The treatment of these two crops is essentially the same from the selection of the soil until cultivation ceases. They delight in a light, deep, sandy soil, but not necessarily very rich. Having thoroughly broken and harrowed the soil, the rows are marked off in checks 5 or 6 feet each way. At each check the manure is applied. About half a bushel or a bushel of good compost and about half a pound of good fertilizer is spread over 6 or 9 square feet at each check and thoroughly worked into the soil 8 or 10 inches deep. The seed are planted in the center of the space as soon as danger of frost is over, or a little before. A week later another planting is made in the same hills for fear of the loss of the first by frost or insects.

A week or more in earliness may thus be attained by the second planting in case of the failure of the first. Ten or fifteen seed should be planted in each hill. When the plants are well up thin to six or eight, and again when the blossom buds appear thin to three or four to the hill. Missing hills may be filled by taking up extra plants with a spade, that an abundance of earth may be taken with the plant.

Cultivation must be frequent and thorough, as the vines grow rapidly, and it is not advisable to turn them. The ends of the longer limbs may be pinched when a yard long, leaving less area for hoe and more for the plow, and probably increasing the fruitfulness of the cucumbers. The vines will also be of more compact growth, covering the ground well and aiding in the suppression of weeds. We prefer planting both cantaloupes and cucumbers in continuous rows, doubling the quantity produced on the same area with but little, if any diminution in the size of the product, and with no additional cost except for seed. These rows may be 4, 5 or 6 feet apart, and are opened out deep and broad with turning plow. This may be done by bedding the ground and fertilizing the water furrow. Manures and fertilizers are distributed in liberal quantities in this furrow, and well incorporated with the soil by running several times with scooter. The row is then bedded, rolled, harrowed or raked smooth, and the seed planted in a drill thickly. A seed drill may be used, or they may be planted by hand. In either case enough seed are sown to have one vine every 10 or 12 inches in the row after thinning is through with. After the vines begin to run, the hoe is dispensed with and only the plow or cultivator used. Whether planted in hills or in continuous rows, it is not necessary that the plants be on a high bed unless the soil is too wet for these crops, but the whole surface of the field should be level, or nearly so.

Cucumbers should be gathered every other day and none allowed to mature on the vines; as the vines decline rapidly after ripening fruit. As soon as the blossom end develops the cucumber is ready for gathering, which is done with a sharp knife, leaving about a quarter or half an inch of the stem attached to the fruit. They are shipped in crates, each cucumber being evenly and firmly pressed down and the crate so filled and packed that there will be no shrinkage before they reach the market.

The Improved White Spine seems to be the favorite market variety. The Early Russian or Siberian is the earliest, but small. Thorburn's Everbearing is early, prolific, and continues in bearing longer than any variety we have tested. For market purposes the New Orleans Market is one of the best, and equal to if not superior to the White Spine.

Cantaloupes are shipped either in crates or barrels—the small varieties frequently in half-barrel crates. To protect from bruising they should be packed in soft hay or moss. The melons intended for shipping are gathered before colored, their near approach to ripening being indicated by the stem beginning to part from the melon, and by the exudation of a redish gum on the stem and melon where they join.

New Orleans Market, Baltimore, Nixon, Montreal Market, Jenny Lind, Emerald Gem, Green Citron and Hackensack are good varieties for market. At Camden none of the above have equaled the Melrose in quality, and after 3 years trial, pronounce it the best we have grown.

GARDEN CORN.

On account of its bulky nature corn can rarely be shipped for roasting ears with much profit, though there may be profit in shipping a very early crop in car lots to Northern markets. It is a favorite crop for local market in many localities of the State, but too frequently is it the case that the common field varieties are depended upon. The garden varieties are much earlier and far superior in flavor. A fall crop planted in September will be in the roasting ear stage about the time the first killing frost occurs. If cut, stalk and all, and stored in some cool place it will keep fresh for two or four weeks according to the weather. Adams' Early, though not a sweet corn, may be planted earlier than the sweet varieties, and is popular on that account. It should be planted early in March, and other plantings made at intervals of seven or ten days until the latter part of the month, when the sweet varieties may be put in. No sweet, extra early variety, has excelled the Early Fordhook at Camden. It is as early as the Cory, better flavored, and has twice as large ears. The main crop sweet corns that have proven best are Stowell's Evergreen and Country Gentleman. The sweet varieties are planted the last week of March or 1st of April.

UPLAND CRESS.

This vegetable is but little known, but deserves a place in every garden. If planted in the early fall it will generally supply the table throughout the winter. It is drilled in rows, 12 or 18 inches apart, and cultivated and cooked like spinach, for which it is a fair substitute. Its flavor is distinct, and considered by many superior to turnip greens.

EGGPLANT.

The best soil for eggplant is a warm, sandy loam, well drained, deeply broken and very fertile. The soil cannot well be too rich for this vegetable, and no matter how rich it may be, a generous quantity of manure and fertilizers should be given if the best results are desired. This should be put down broadcast before the plants are transferred to the field. The seed are sown in hotbeds about the 1st of February, and when the third leaf appears are transplanted to other beds, shallow boxes or pots and set

2 inches apart. Before they begin to crowd they are again set further apart and finally transferred to the field the middle of April or early in May The eggplant is of tropical origin and very susceptible to cold. From the time the seed are sown until permanent warm weather sets in, a high temperature should be maintained that the plants may not be checked in their growth. There should be well developed fruit by June 15. The plants are set 3x3 or 3x4 feet if of the large varieties, but 3x2 is sufficient distance for the dwarfs, and even 2x2 is not too close if the dwarfs are not to be used after the standard varieties begin to fruit.

Cultivation should be shallow, frequent and continued as long as the plants will admit of the passage of the plow between the rows. A top dressing of nitrate of soda and muriate of potash applied when the first fruits are forming will be of marked benefit.

Eggplants are gathered for market when from 2 to 4 inches in diameter, by cutting the stem with a strong, sharp knife. They are shipped in barrels or barrel crates, each package containing fruits of uniform size.

The New York Purple and Black Pekin are the standard market varieties. The Early Round or Oval are from two to three weeks earlier than the first named varieties; the fruit is very small, however, and practically worthless when the large varieties come in bearing. The past season the White Pearl withstood the severe drouth better than any of the half-dozen varieties grown, and was larger, more prolific and possessed as good cooking qualities as any, but its very white color is objected to until it is better known. The New Orleans Market has produced better fruit at Camden than the New York Purple.

KALE OR BORECOLE.

This vegetable does not ship well, and consequently is grown principally for local market and home use. It will endure very cold weather and is improved by being frozen. It is sown from August to November in beds and transplanted, or sown in rows 2 or 3 feet apart and thinned to 18 inches in the row. It is transplanted like cabbage. Dwarf Curled Scotch is the best variety, and very ornamental in appearance.

LETTUCE.

Lettuce may be grown at a much lower degree of temperature than many suppose. Ordinarily 25 degrees will do it but slight damage. While at Camden, some varieties, without protection, passed through the winter of 1895-96, furnishing the table from December until spring. The more tender varieties are rarely killed in the southern part of the State before the middle of December. From then until spring the supply can easily be maintained in hotbeds or cold frames. The spring crop is transplanted the latter part of February or early in March, from seed sown in January. To keep up the supply seed are sown at intervals until April. The early sowings of seed are made in hotbeds, but after the 1st of March may be sown in the open. When large enough the plants are transplanted to their permanent rows, which may be from 12 to 24 inches apart, and the plants set 6 to 12 inches in the row. Liberal manuring and cultivation, and ample room between plants are necessary to the production of good heads. It is practically impossible to grow good heads from the common practice of sowing the seed broadcast. We transplant lettuce by using the right index finger as a dibber, setting the plants well up to the lower leaves, and firmly pressing the soil around them with the foot. When half grown the plants will be greatly benefited by a top dressing of nitrate of soda and muriate of potash. These, however, must not come in contact with the leaves.

Lettuce is shipped in barrels or crates, and requires careful packing. Each head should be so firmly placed that there will be no shaking before it reaches its destination, and at the same time the leaves must be bruised as little as possible.

Popular market varieties are Tennis Ball or Boston Market, Grand Rapids, Black Seeded Simpson, Hanson and New Orleans Passion; none of which have done better at Camden than the last named. For home use we prefer the Morse and California All Heart. For forcing, Grand Rapids. The Morse, California All Heart and Dwarf White Heart Cos are preferred. The latter will bear very close planting.

OKRA.

This vegetable is as easily grown as cotton, to which it is botanically related. The seed should not be planted until the ground becomes warm, and should be given a deep and rich soil. The well manured rows are from 3 to 4 feet wide, and plants left in the row from 1 to 3 feet, according to the variety. The pods should all be gathered when of the proper size. If left to mature the fruitfulness of the plant will be impaired. Okra is used in soups, or may be boiled or fried. It is easily kept all winter in strong brine, or it may be sliced and dried. The tall and dwarf velvet varieties are the best.

ONIONS FROM SEED.

Until a few years ago it was not generally known that onions of large size could be grown at the South the first year from the seed, but all were grown from sets of the previous year's growth. It has now been demonstrated from experience that the South can grow as fine onions direct from the seed as any other section, the fertility of the soil being equal. Late planting, insufficient manuring and shiftless cultivation are, however, prevalent causes of failure. No crop requires more thorough preparation, or more constant cultivation. There is probably no crop that promises greater profit than the onion, whether shipped bunched in the green state or harvested and shipped as ripe onions. In either case the crop comes into the Northern market when the supply is least and the prices highest. Expert onion growers produce 400 or 500 bushels per acre, and sometimes the yield is as high as 1,000 bushels.

SOIL AND ITS PREPARATION.

The best soil for onions is well drained sandy loam with clay subsoil, and containing an abundance of humus. The field should be nearly or quite level, and freed from all roots and trash. Soil that has been under high cultivation for a number of years is preferable. No matter how fertile the field may be in its owner's estimation, he cannot expect the best results until it has grown onions for several years, and in the meantime kept free from all weeds and heavily manured for each crop. As onions may be grown on the same soil for any number of years, and under equal conditions will each year give a better yield, it follows that this crop should be an exception as regards rotation of soil. A rotation of manures will be needed, however, and particularly so if commercial fertilizers are used to any considerable extent. This rotation is secured by either stable manure or green manuring, or both when commercial fertilizers have been extensively used and *vice versa*. As the onions are harvested in June and early in July, ample time remains for a crop of cowpeas to be grown and plowed in, and the soil prepared for the fall sowing of seed. It is of the utmost importance that the land be plowed, harrowed and rolled (and raked if necessary) until it is brought to the best possible condition. The manure which has been so manipulated as to free it from all lumps and litter is evenly distributed broadcast and worked into the soil. The preparation should begin some weeks before planting time, that there be no mistake as to its being properly done. Clean culture the previous year will be a great saving in the preparation and cultivation of the next crop.

SOWING THE SEED IN HOTBEDS OR GREENHOUSE.

The hotbeds should be gotten ready between December 1 and 15, and the surface of the soil stirred every few days to induce the germination of all weed seed before the onions are planted. The seed are sown between December 20 and January 10 in 3-inch rows, covering them about half an inch. An ounce of seed will sow 18 square feet of surface, or the area covered by one 3x6-foot hotbed sash. The bed must not be allowed to become either too dry or too wet, and it is of the greatest importance that an abundance of air be given the plants by removing the sash on all warm or bright days. In five or six weeks the young onions should be one-sixth or one-fourth inch in diameter, and are ready for transplanting, having been thoroughly hardened off.

TRANSPLANTING.

If cultivation is to be done by hand the rows are marked off 12 or 15 inches apart, and twice as wide if the plow is to be used. Cultivation is greatly facilitated by having the rows exactly the same distance apart throughout their entire length. To secure this the first row should be marked by stretching a line as a guide and a marker made for the purpose used for the others. A good marker, and one easily made, somewhat resembles a rake. A 2x4 scantling, 8 or 12 feet long, and with pegs 6 or 8 inches long inserted in auger holes bored at intervals equal to the distance the rows are to be, will be serviceable. This device is drawn by two long handles, the pegs marking the rows. It may then be drawn across the rows, the marks thus made being good guides for spacing the plants, which should be set 3 inches apart in the rows. Transplanting should begin as soon after February 15 as the ground can be gotten in order. The plants are taken from the hotbed by inserting a trowel, or some similar instrument, well under and prying them up. They must never be pulled up. The soil is then gently shaken from the roots, the plants placed evenly in bunches of a few hundred, and about one-third each of the roots and tops cut off with a sharp knife. They are then planted in the checks previously marked off. We have tried various ways of transplanting and prefer using no tools besides the hands. If the soil is in the proper condition the right forefinger may be used as a dibber to greater advantage than a wooden or iron one, and particularly is this advantage apparent as regards the rapidity of setting out. A good hand should set out 5,000 in 10 hours. Another way is to open the rows with the plow attachment of a hand wheel hoe, lay the plant against the perpendicular side of the furrow and cover with the same implement, pressing the soil firm with the foot.

The advantages of starting the plants in hotbeds over the practice of sowing the seed where they are to grow, are:

a. Less hand-weeding and cultivation are required, and no thinning, which is more than enough to compensate for the additional expense up to the time cultivation begins.

b. The crop matures 2 or 3 weeks earlier and is less liable to injury from drouth.

c. The yield, quality, shape and size are improved.

d. The early maturity gives a proportionately longer use of the land.

SOWING SEED IN THE OPEN GROUND.

The method most commonly practiced is to sow the seed where the crop is to grow as early in the spring as they can be gotten into the ground, or to sow them the previous October. There is some danger of the October sowing being winter killed, but in South Arkansas this will rarely occur. The onion is one of the hardiest of vegetables. Well grown onions, both from seeds and from sets, survived the winter of 1894 and 1895 with but slight injury when the temperature was below zero. The preparation of the ground is the same, whether for transplanting from hotbed or sowing seed in permanent rows. The seed are sown in drills 15 to 30 inches apart. A seed drill should be used for this purpose, and from 15 to 30 seed sown to every foot of row. When the plants are 2 or 3 inches high, they are thinned to 3 inches in the drill. A few radish seed sown with the onions will serve to mark the row for the first cultivation. The radish seed germinate readily and will appear within a week, while the onions germinate slowly, and frequently require slight cultivation before they show along the rows. The October sowing, however, will require little attention before February.

CULTIVATION.

The proper cultivation of a crop of onions is no small undertaking, and with the presence of all other essentials, the neglect of this one will invariably result in failure. For the spring sown crop it is not infrequently the case that cultivation should begin before they are up, and it is important that radish or turnip seed be sown with the onions to indicate the rows and serve as a guide for the first cultivation. No weeds should at any time be allowed to grow, and the easiest, cheapest, and in all respects the best way to prevent their growth is to cultivate so frequently that they are destroyed just as they appear above ground or before. After the onions are well under way the cultivation should be about an inch deep, as the roots are near the surface and should be disturbed as little as possible, consistent with keeping the soil's surface well stirred. The young onions are thinned to 2, 3 or 4 inches when about one-eighth of an inch in diameter. Missing places may be filled by transplanting the thinnings. If the rows are not far enough apart to admit of cultivation with plows, the Planet, Jr., double-wheel hoe is the proper implement to cultivate with, though a hoe may be used. Special onion hoes are made for this purpose. No small part of the early cultivation must be done by hand, and Lang's hand weeder or some similar tool is about indispensable for removing weeds from near the bulbs without injuring them. The weeds, if of any size, should neither be pulled up nor merely have their tops cut off, but cut under the ground that there be no danger of their reappearance. As soon after each rain as the ground is dry enough to be lightly stirred, the field should be gone over and the space between the rows thoroughly scarified for the double purpose of preventing the formation of crust and the destruction of germinating weed seed.

A soil with a well pulverized and loose surface will retain moisture more than twice as long as one with a crust, and cultivation should continue at frequent intervals in dry weather, whether weeds appear or not. After the crop has been harvested cultivation should continue so as to prevent weed seed from maturing on the ground to harrass the future crop. This will also be prevented by sowing cowpeas broadcast at the rate of two bushels per acre. The vines will smother the weeds and at the same time enrich the soil.

HARVESTING.

Onions are ripe or ready to be gathered when the tops fall, and should then be pulled up and left thinly spread to cure, which will require five or six days of clear, dry weather, and longer if the weather is less favorable. No rain should fall on them after they are pulled up. To prevent this it is safer to spread them under sheds or on barn floors, subject to free circulation of air. When thoroughly dry and the tops brittle, the tops are removed, and the onions sorted into three grades.

MARKETING.

Onions should be marketed as soon after they are cured as possible, as they do not keep well in hot weather. Maturity is reached in June and July, and before the Northern crop is on the market, and when prices are generally the highest. The shipping is done in bushel or barrel crates, but large quantities in bulk.

VARIETIES.

There are many varieties of onions, and they do not succeed alike on different soils or in different climates. For starting under glass the Prizetaker and Gigantic Gibralta have surpassed all others tested at Camden, and are among the best for the spring planting in the open ground. For sowing in February and March the following varieties have given good results: Early Red Globe, Southport White and Red Globe, Giant Rocca, Bermudas, Yellow Danvers and Large Red Wethersfield. The White Multiplier or Potato Onion is excellent for early bunching, when the sets are planted in September or October. Planted on October 3, 1895, they were ready for market early in the following February. A small area sold at the rate of $560 per acre.

GROWING SETS.

The seed for producing sets should be Southern grown. They are sown thickly, or about 25 pounds per acre, in drills in April on soil that is comparatively poor. The cultivation is the same as for the main crop, except that no thinning is done. They are cured and stored in a well ventilated, cool and dry place until planting time. The tops should be left on until just before they are to be planted, as they do not keep so well with the tops removed earlier in the season.

PLANTING SETS.

The character of soil and its preparation is the sâme for planting sets as for the spring crop from seed. In fact, the two crops may be grown on the same soil if the sets are to be sold as green bunching onions. The sets should be planted as soon after September 1 as the season will permit. They are not covered but merely pressed into the loose soil so as to hold them in place, and a very slightly elevated ridge will be of some protection in very wet weather in winter. Clean cultivation should be given until the first killing frost, after which they will require no attention until February, when they are kept clean by shallow cultivation. A top dressing of equal parts of nitrate of soda and muriate of potash will hasten growth. They will be ready for bunching the latter part of February and early in March, when they are washed and eight or twelve tied in neat bunches. To keep up a succession, sets may be planted in January and February. Ripe onions from seed keep better than those from sets.

PARSNIP.

(Cultural directions same as for Carrots, which see.) The Hollow Crown or Sugar is the best variety.

PEPPER.

Directions for Eggplants apply equally as well for pepper except that the latter may not be given so much distance. Of the sweet varieties the following are recommended: Sweet Spanish, Procop's Giant, Golden Dawn, Golden Queen and Ruby King. For hot: Long Red Cayenne, Chili, Tabasco and Red Cluster.

IRISH POTATO.

See Bulletin No. 38.

ENGLISH PEA.

This vegetable will survive quite a low temperature without serious injury, and may be planted earlier than is commonly the custom. The early spring sowing should be made early in February, and in mild winters it may pay to risk a sowing in January. If the soil intended for peas has grown a crop of cowpeas or clover the year previous it will not be necessary to use fertilizers containing nitrogen, but only phosphoric acid and potash. Too much nitrogen in the soil will induce a rank vine growth and increase the possibility of injury from freezing. The ground should be gotten ready as early as possible, preparing the rows from 2 to 4 feet wide according to the variety. For market the dwarf varieties are almost invariably planted to avoid the additional expense of "sticking" or "brushing." That the vines may be better supported it is the custom to plant double or treble rows, 1 or 2 inches apart, that the vines may support each other, or the seed are scattered in broad drills, 4 or 5 inches wide. Successive plantings, made at intervals of a week or ten days, will keep up the supply. The fall crops are planted from August 15 to October 1, and will supply peas until late in December in an average season. The seed of both fall and spring crops should be covered about 2 inches. The earliest spring crops should be planted on a slightly elevated ridge, while the late spring and fall crops require level planting. Cultivation should be frequent and thorough.

GATHERING AND MARKETING.

As soon as the pods are filled they are gathered by hand without injury to the vines, and tightly packed in the ordinary vegetable crates without sorting, and shipped at once.

VARIETIES.

The earliest variety is the Alaska, and valuable for market on this account, and because practically all the crop may be gathered at once. The Early May, First and Best, Early Washington, Early Frame, Early June and Early Kent are all the same, or different strains of the same variety, and extensively planted for the first crop. Daniel O'Rourke, American Wonder and Carter's First Crop are good early varieties. Of the second early and late varieties the following are good: The Marrowfats, Advancer, Strategem, Pride of the Market, Laxtons Prolific Long Pod and Champion of England.

RADISH.

To be crisp and well flavored, radishes should be given a light, mellow and thoroughly drained sandy loam, and be made to grow rapidly by liberal manuring and frequent cultivation. The manure must be evenly and deeply worked into the soil, and should not be fresh or coarse. Fresh animal manures should not be used, unless applied to a previous crop. Commercial fertilizers are best, and a top dressing of nitrate of soda and muriate of potash applied when the roots begin to enlarge and worked into the soil will give marked results. This top dressing must be applied when the leaves are perfectly dry. The seed may be sown broadcast or in rows 12 or 18 inches apart, and may be planted from February until June and from September until November.

Radishes lose their crispness quickly, and are not well adapted to shipping, except for short distances. They are shipped in well ventilated barrels or crates. They are washed and tied in neat bunches of uniform size, and firmly packed.

The Half Long French, Long Scarlet Short Top, Scarlet Turnip and White Tipped Olive-shaped are good varieties for either spring or fall, while Chinese Rose, White Strasburg and White California Mammoth are good winter varieties. The Black Spanish is preferred in some markets. Golden Globe and White Strasburg are good summer varieties. For forcing, the Earliest White is the best tested at Camden, and was ready for the table in twenty days from sowing the seed.

SALSIFY OR OYSTER PLANT.

This vegetable, though planted by few, is not only a delicious, but an important one for the home garden. It is available for cooking from early fall until late spring, through a period when there is the greatest scarcity of vegetables.

Salsify requires a deep, rich soil that has been well manured the year previous. Sandy loam is best, though it will grow on the majority of soils, if they are fertile and well prepared. Coarse or fresh manures must be avoided, as they have a tendency to make the roots fork and scar. Prepare the soil 8 or 12 inches deep, and make it as near as possible the same texture and fertility throughout. The seed are sown thickly in narrow drills 1 or 2 feet apart, and plants left 1 or 2 inches in the drill, or even closer, if the soil is very fertile. Missing places may be filled by transplanting. The seed should be sown quite early in the spring, and the ground kept free from weeds by frequent cultivation. Salsify is one of the most hardy of vegetables and is rarely winter killed. When it is thought necessary to protect it, two furrows with turning plow may be thrown on the rows in December, or the plants may be taken up and stored thickly in trenches. In the Southern portions of the State no winter protection is necesary.

When cooked the flavor of salsify is very suggestive of the oyster, hence its name *oyster plant* or *vegetable oyster*. In cooking salsify the roots are first boiled, when they may be sliced and fried, or stewed or made into soup after the manner of cooking fresh oysters.

SPINACH.

On fertile soil spinach is one of the easiest crops to grow that the gardener has to do with, and it is a little strange that this vegetable has not become a fixture in the winter and spring gardens of the South. It requires no protection in South Arkansas, and will grow throughout the greater part of the winter. At Camden it has proven to be even hardier than the strap-leaved turnip, and is far superior to turnip salad as a table dish. The seed are planted in drills 18 to 30 inches apart early in September and the plants thinned to 4 inches in the drill. Every other plant may be used during winter and the remaining ones left for spring. Very little cultivation is necessary except in the early fall, when quite young, and again in the early spring. Seed for the spring crop may be sown as late as November.

Spinach is shipped in ventilated barrels. The plants are cut at the root, carefully placed in the barrels and well pressed down.

The Bloomsdale Curled Savoy is the most popular variety, though the Broad Flanders and Victoria have proven equally as good at Camden.

SQUASH.

Directions for cantaloupes and cucumbers apply equally well for the squash, though the later long-vined varieties should be given more distance.

The Patty Pan or Bush Scallop, the Summer Crookneck and Pineapple are favorite varieties, Patty Pan being preferred for shipping and the Crookneck for home use.

TOMATO.

This crop, when it reaches the market early, is one of the most profitable the gardener can grow. In several of the Southern States tomato growing for the Northern market is carried on quite extensively and shipments made before the middle of July bring good prices, while the extra early crop frequently sell as high as $1 a dozen. Plants started under glass at Camden and transplanted as soon as danger of frost was over ripened fruit on May 18. The gardener who is to undertake extensive or permanent early tomato growing for market should be provided with a greenhouse and cold frames. Hotbeds may be used in the place of the former, but a greenhouse is far more satisfactory and in the long run, cheaper.

SOWING THE SEED.

The seed are sown about January 1, in boxes or trays 2 or 3 inches deep and of a size convenient for handling and so as to fit the greenhouse benches without the loss of space. If the plants are to be grown in hotbeds, the trays should be 24x36 inches or three to each sash; or 24x18 inches with six to the sash. The seed are sown rather thickly in rows 2 inches apart and covered ⅓ or ½-inch. The soil should be sufficiently moist when the seed are planted to induce germination, as no water should be given until the plants are well up. As soon as the seed are planted the trays should be covered with moss, old sacks or some similar material to retain the moisture, but this covering must be removed upon the appearance of the first sign of germination. Water should be withheld until there are indications of its need. When the third or first rough leaf appears the plants are taken up and transplanted to other trays, setting the plants 2 inches each way and a little deeper than they were at first. All the light and air must be given that the temperature will allow, or only long and spindling plants will develop. The night temperature of the seedlings should be about 55 degrees and 5 degrees lower after the first transplanting. Before the plants begin to crowd each other they are again transplanted, but 4 inches apart. Other trays may be used or the plants may be set in cold frames. If 3-inch pots or old berry boxes are at hand the plants may be transferred to these and placed in the greenhouse or cold frames. The plants must still have an abundance of air and may be given increased quantities of water. The plants intended for the early crop should be in the cold frames by the 1st of March, and a month later are ready for transplanting. The last week or ten days they occupy the frames the plants should be exposed to all the adverse weather that they can endure without injury. This is to avoid the evil effects of the change from their accustomed surroundings and prevent a check in their growth. Water should be entirely withheld for several days before the final transplanting but applied freely just before the plants are taken up.

PREPARATION OF THE FIELD.

The soil should be a deep, sandy loam and a southern exposure is preferable for the early crop. If fungous diseases are troublesome, tomatoes should not be grown twice in succession on the same soil, nor should they follow eggplants or Irish potatoes, as these plants are subject to the same fungus and insect attacks as the tomato. The soil is thoroughly and deeply broken and a goodly portion of the manure applied broadcast, the remainder to be put in the drill. The rows are marked off 3 or 4 feet wide and the plants set the same distances in the rows, forming checks, that cultivation with the plow may be done both ways. A slightly elevated ridge is preferable for the extra early crop, but the later should be level.

FINAL TRANSPLANTING.

The final transplanting should be made between the 1st and 15th of April, when the weather is favorable, but a sufficient quantity of plants retained in frames in case the first planting should succumb to too cold weather. The last killing frost at Camden generally occurs about the first week in April, and two or three weeks later in the extreme northern part of the State. It is advisable, however, to run some risk of frost.

Last spring and the spring before plants after being set in the field at Camden were saved from a killing frost by bending the plants over and covering with loose earth, and by covering with two thicknesses of old newspapers held in place by earth on the edges so that the bulging center inclosed the plants. It was necessary on one occasion to protect the plants three nights in succession when the paper was found to be far more convenient as it could be readily removed during the day and replaced at night; and when left covering the plants all day no injury resulted, while the covering of earth bleached and weakened the plants. Strawberry boxes may be used to advantage when the plants are small and will protect from frost. In case of a freeze the boxes should be covered with earth. These devices for protecting from cold may be used for other plants as well as for tomatoes, and a little forethought and labor be the means of having many vegetables several weeks earlier than would be the case without protection.

A few hours before transplanting is to begin the plants should be thoroughly watered. The plants grow off more promptly if set late in the afternoon or on cloudy days. The soil should not be too wet but in good working condition. The plants should be set in the ground at least half their length deeper than they stood before being taken up. The earth must be firmly pressed around the plants with the foot and the footprints covered over with loose earth. If the plants are grown in pots or berry boxes they are planted with the earth intact and firmly pressed down as directed above. These plants will not wilt when transplanted and will ripen fruit several days in advance of those treated in the ordinary manner. These boxes and pots will be found to be of great service and may be used for cabbage and cauliflower before the tomato plants are ready for them. With careful handling the pots will last indefinitely and the boxes may be used two or three times. The boxes in which the plants were grown should be left in the field for use in case of frost, but must be weighted down with earth to prevent their being blown away by high winds.

CULTIVATION.

Cultivation should begin soon after the plants are transferred to the field. If both the rows and checks are straight, plow cultivation will be facilitated, leaving but little for the hoe. A 24-inch heel sweep will do the work admirably, as such an implement can be run nearer the plants than any other without bruising. The wings of the heel sweep extends under the vines after they have spread over a portion of the row, stirs the soil and destroys the weeds where no other plow can reach without injury to the vines. It leaves less work for the hoe, and at the same time gives level and shallow cultivation. The roots of the vines should not be broken, particularly after the first blossoms appear, but shallow cultivation should be continued until the first fruit ripens, and after, if the soil threatens to become dry or weeds appear.

PRUNING.

If the branches that appear below the first cluster of blossoms are permitted to grow the tomatoes will not ripen so early, nor will they be of as good size and shape, for these lower branches consume a considerable portion of the food that would better develop the earliest fruit. Pruning above the first blossom cluster is of doubtful advantage. When pruning is practiced the young branches should be *rubbed* off as soon as they appear and before they have appropriated food intended for the main stalk or fruit. The largest yield is generally made by the unpruned vines. Pruning will secure the earliest and largest tomatoes, but does not pay after the first fruit has developed.

TYING.

Tying, like pruning, is of doubtful advantage, except in the home garden, where economy of space is important. The common cane of the river bottoms is unsurpassed for stakes—they are straight, light, strong and not so unsightly. They should not be less than half an inch in diameter and 4 feet long. They are set firmly in the ground, 2 or 3 inches from the vine. Before there is danger of injury to the vines from being blown over the tying begins. Cheap cotton cord, sisal or raffia will answer, but nothing that would cut the vines should be used. Unless the tying is properly done the strings are apt to slip down the stakes. To prevent this, wrap the string once around the stake above a joint and tie firmly before tying the vine, which should have enough room to prevent cutting by the string as the vine grows. The tying must continue at intervals and before the tops of the vines have grown so long as to fall over.

Vines allowed to spread upon the ground, or not tied, suffer less from drouth than those tied, and are more fruitful, but the fruit is more inclined to rot in wet weather.

GATHERING AND MARKETING.

Tomatoes intended for distant markets are gathered before they are thoroughly ripe, the degree of ripeness being determined by the time required for them to reach their destination, and some experience is necessary to determine just when to gather. Temperature, light and variety affect the time required for ripening. When coloring begins, the gathered tomatoes will ripen, under normal summer conditions, in from two to six days. The time required by the different varieties at various stages of coloring to thoroughly ripen, may be accurately determined by gathering a few specimens and storing them under conditions as nearly as possible similar to the conditions which surround them in transit. A daily inspection of the different lots will indicate the time required for each variety to ripen.

Gathering must be carefully done to avoid bruising, and the stems be removed, as they interfere with proper packing and increase the danger of bruising. The sorting must be done in several lots according to size, shape and degree of ripeness, rejecting all worm-eaten or specked fruit. The culls may be fed to poultry or stock. No defective fruit should be left in the field, but removed and destroyed, as they will be prolific in the propagation of fungous diseases and insects. If allowed to remain on the vines their fruitfulness will be interfered with. Each tomato should be wrapped in thin paper and firmly fitted into its place. Many shippers do not wrap in paper but it is advisable, particularly for the better grades. Before gathering begins everything should be in readiness and the crates packed and shipped as soon after the tomatoes are gathered as is possible and consistent with good packing.

VARIETIES.

There are so many good varieties of tomatoes that it is difficult to select the few best. All of the following varieties are good: Essex Hybrid, Aristocrat, Acme, Perfection, Beauty, New Imperial, Mikado, Matchless, New Stone, Dwarf Champion, Ponderosa, Lemon Blush and Golden Queen. Of the above Essex Hybrid has been earliest, but a few days later than Fordhook First and Early Advance.

FALL AND WINTER TOMATOES.

The seed for the late crops should be sown in May and June and transplanted when the plants are of the proper size. We prefer, however, to plant cuttings from select vines. These take root readily, but may require shading and watering until well established. The cuttings are made in July or early in August and should not be less than a foot in length. The lower leaves are cut off and the cuttings put in the ground to about three-fourths of their length and soil packed firmly about them. The branches may also be bent down and covered with earth until rooted before taking them from the parent plant.

In the summer of 1895 we had one vine of the variety Ponderosa from which was gathered fourteen tomatoes weighing 11 pounds, the largest of which weighed 24 ounces. They were all unusually smooth and of uniform size. In July twenty-four cuttings were made from this vine, nineteen of which lived and furnished a little more than one bushel of fruit before frost and very near as much more after. Other cuttings were made from these and bore fruit through the winter in the greenhouse. Cuttings were again made from the greenhouse plants early in the spring which bore fruit almost as large as the original plant, but not so well shaped. This was probably due to the severe drouth, which killed all the plants late in July, 1896.

Cuttings, or seedling plants, put out for a fall crop will furnish ripe fruit until frost, and then leave a green crop on the vines. If the vines are then pulled up and hung in a cellar or some dark, cool place, the fruit will continue to ripen until Christmas or later. A better plan than pulling the whole vine is to gather all the tomatoes with some stem when there is danger of frost. Each tomato is then wrapped in paper and stored in a dark, cool place, but not allowed to freeze. As they are needed they are brought to a light, warm room, where they will soon ripen. Only those that have begun to color should be brought out. With facilities for storing large quantities of green tomatoes the winter crop could be made quite profitable, as well ripened tomatoes, of good shape, bring fancy prices at this season of the year.

TURNIPS.

Turnips are generally sown broadcast, but if drilled in rows 12 or 18 inches apart, the yield and fruit will both be larger, if a little cultivation is given. The turnip is the most popular winter vegetable that is grown in Southern Arkansas, and more frequently is the only occupant of private gardens than is it found associated with other winter vegetables.

Turnips are rarely a profitable crop for the market gardener, except for local market; though there may be some profit in the early spring crop for Northern shipment. The spring crop is sown late in February or early in March, and thinned to 3 or 4 inches in the drill and well cultivated. For fall crops the Ruta Bagas should be sown between June 15 and August 1; and other varieties from July 15 to September 1. The seed should be sown when the soil is moist to insure immediate germination. The fall crop requires more cultivation than the spring; the soil should be kept mellow by frequent stirring and no weeds allowed to grow.

Good varieties for spring sowing are: Extra Early Milan, Early Red or Purple Top, Early Flat Dutch, and Red Top White Globe. Good fall varieties are: White Globe, Red Top White Globe, Yellow Aberdeen, Yellow Amber, White Egg and White Navet. The Sweedish turnip, or Ruta Baga type are not planted for the spring crop, but are unexcelled for fall and winter. Turnips keep well all winter if merely covered a foot or more in the field after placing 10 or 20 bushels in a conical shaped heap. The Seven Top is the best variety for fall, winter and spring salad, on account of its extreme hardiness and abundance of leaves.

WATERMELON.

Watermelons do best on thoroughly drained and warm, dry soil. Bottom land is not well suited to the early crop, but is better for the late. A reclaimed old field is excellent and new ground is good. The pine thickets that appear on fields that were once in cultivation may profitably be given to this crop. Planting is done in checks not less than 9 feet each way. The checks are marked off with plow and at each intersection the manure is placed in a broad, shallow hole, and well mixed with the soil by working over with hoe or shovel. Over this the hill is made, which should be 8 or 10 inches high when new. This should be done three or four weeks before the seed are to be planted. Just before planting the hills are leveled down until the broad, flat top stands 2 or 3 inches above the surface of the ground. The manure for watermelons should be prepared some time before the hills are to be made and may consist of well rotted stable or barnyard manure or a good compost. From three to five shovelsfull should be placed in each hill. With this is worked in about a pound of a complete fertilizer, or five parts cotton seed meal, three parts kainite and two parts phosphoric acid, thoroughly mixed. The seed are planted an inch deep, near the center of the hill. For an extra early crop the planting should be done as early in the spring as there is a possible chance of the young plant escaping frost, and additional plantings made in the same hill at intervals of a week or ten days, until a stand is secured. The vines are finally thinned to two in each hill. As soon as they are well up, the hills are stirred lightly and the cultivator, or heel sweep, run through the middle. A sprinkling of air-slacked lime and tobacco dust will drive away the striped beetle. Cultivation should be frequent and continued until the vines interfere. They should not be moved or disturbed during cultivation.

To secure extra early watermelons, cantaloupes or cucumbers, the seed may be planted in pots, berry boxes or inverted sods, and started in greenhouses or hotbeds. When danger of frost is passed, they are transplanted without breaking the ball of earth.

Watermelons are shipped in bulk in box cars, with straw at the bottom and on the sides to protect from bruising.

The most popular shipping varieties are the Kolb Gem and Georgia Rattlesnake. The Jones is equal to either of the above for shipping and superior in flavor. Cuban Queen, Jones, Sugar Loaf, Fordhook Early and Florida Favorite are good for home use or local market, and far superior to the regular shipping varieties. Fordhook Early has ripened fruit first on the Station grounds for two years, and for an extra early variety is of excellent quality.

MILK—ITS DECOMPOSITION AND PRESERVATION.

Part I.

THE SPONTANEOUS CHANGES WHICH OCCUR IN MILK.

The relation of bacteria to the changes which take place in milk and to the ordinary processes employed in the preparation of dairy products has only been fully appreciated within the last few years, although in no connection which the bacteria bear to our everyday life is a knowledge of the subject of more practical importance than in the handling of milk. It is with the aim of supplying information on this subject that a popular presentation of the more important facts of dairy bacteriology is here offered. The bearing and importance of the original researches undertaken in this laboratory on milk bacteria can thus be better understood and appreciated. A general understanding of the conditions and agencies upon which milk decompositions depend supplies the only true basis for successful methods in dairying. In the household, also, from some points of view, the subject is no less important than in the dairy. In the preparation of the popular part of this bulletin the more recent works and reports on dairy bacteriology have been consulted and more or less drawn upon. The subject of milk handling is considered only from the standpoint of the bacteriologist; the details of practical dairying are not considered.

Milk, like meats, soups, and other albuminous foods, is prone to decomposition, not, as was formerly believed, from any inherent instability in its composition, but from the fact of its offering a favorable breeding ground for those microscopic living organisms or "germs" which practically are as nearly omnipresent as the air which surrounds us. If the access of these germs could be prevented, milk would not sour nor meat putrefy, however long they were kept. The methods employed in permanently preserving meats and other perishable foodstuffs have for their basis the destruction of the living organisms present and preventing their access later; or, in other cases, rendering the food unsuitable for bacterial growth by drying, salting, addition of sugar, etc. Condensed milk owes its preservation to its concentration and high sugar content.

Although total exclusion of bacteria from milk is not practically attainable, the extent of bacterial infection and the rapidity of bacterial multiplication—the two factors upon which milk decomposition depends—are largely under control of the milkman.

In order to learn something of the decomposition of milk it is necessary that we understand its composition.

Composition of Milk. Milk is described as an emulsion; that is, it consists of minute globules of a fatty or oil-like substance suspended or intimately mixed in fluid. The fat globules, when separated from the fluid by churning, constitute the butter. The other constituents of milk are present in solution or partial solution in the fluid. Of these casein is the chief representative of the proteid or muscle forming element of foods. Lactose is a form of sugar (sugar of milk); albumen and inorganic salts are present in small amounts. Fat, lactose, and casein, as may be seen from the table, are (after the water) the three constituents present in by far the largest proportion.

Average percentage composition of cow's milk:*

Water	87.20
Total solids	12.80
Fats	3.65
Solids not fat	9.15
Casein and albumen	3.57
Milk sugar	4.85
Ash	0.71

In milk decomposition not only the proteid constituents but the sugar undergoes change. It is, indeed, the sugar content of the milk which determines chiefly the character of its decomposition, which causes it to sour and curdle rather than putrefy. In the ordinary milk souring the acidity results from a change of the lactose into lactic and other acids—spoken of as the lactic fermentation—a change which is due to the growth in the milk of certain species of bacteria which obtain entrance to it.

Souring and curdling, although usually the most noticeable change occurring in milk, is never the only change. It is a result of the decomposition of the lactose, but the proteid constituents by their decomposition furnish other products varying in amount and character with the different species of bacteria which may be present. The common agents of milk souring (described in Part II.) seem to effect little change except that due to the sugar fermentation. Other species grow in milk without producing any manifest change, although necessarily affecting its composition. Others, again, show their effects on the milk by the production of various unusual colors or odors, by inducing liquefaction of the curdled milk, or by affecting the taste of the milk before souring occurs. Representatives of all of these classes are present in probably all samples of milk as usually obtained, but their effects in stale milk are, in general, masked by that of the more rapidly growing lactic acid germs. In cases in which the proper milk souring germs are present in unusually small numbers, or where there has been an unusually large infection with other organisms, these various modifications of the milk curdling process may be seen. Of the products formed by the growth of bacteria in milk, especially of those formed by the proteid decomposition, almost nothing is known. That they are nearly always harmless, to adults at least, is shown by the rarity of cases of milk poisoning. Buttermilk, in which bacterial multiplication may be said to have almost reached its height, the number being reckoned by millions in every drop, is nevertheless, in general, a wholesome drink. The proneness of milk to undergo the souring process is really a protection against the development of poison producing germs, such as we find in sugar-free albuminous fluids.

---

*Snyder: Chemistry of Dairying; p. 7.

Milk Poisoning. Occasional cases of milk poisoning occur, in which whole families using the milk from a certain source are affected. These cases are almost certainly due to bacterial toxins resulting from some unusual milk infection. Of the source of these toxin producing species almost nothing is known.

Number of Bacteria in Milk. In general it may be said that the number of bacteria in sweet milk furnishes no indication as to its wholesomeness. The number increases the longer the milk is kept till actual souring occurs, and even after this many species continue to multiply. The number in any sample of milk will depend on the age of the milk, the temperature at which it has been kept, and the amount and character or the bacterial seeding which it originally received. These several factors also determine the rapidity of souring, but on account of the variety of species present, many of which are not acid producers, the keeping quality of milk from all sources cannot always be determined by a mere quantitative estimation of the number of bacteria it contains. Observations made on the samples of dairy milk referred to in the table given below, which were kept in sterile cotton-plugged flasks at 20° to 22° C. till thickening commenced, showed no very close relation between the number of germs in the milk and the time of curdling. These observations were not made specially to determine this point, and for several reasons were far from accurate tests. With a lower and less varying temperature, and more exact determination of the time when the milk first becomes unpalatable, some closer relation might be expected in samples from the same dairy.

In a general way only can the number of bacteria in any sample of milk be taken as an indication of its purity. Unless the age of the milk and the temperature at which it has been kept are considered, mere numbers indicate nothing. Milk, fresh from the cow, before multiplication has occurred, should contain only a small number of bacteria, if proper cleanliness has been observed. The second table of quantitative biological analysis shows what improvement in bacterial content may be obtained by reasonable precautions. In these tests greater cleanliness in milking was accompanied not only with smaller numbers of bacteria, but with marked improvement in the keeping quality of the milk.

The subjoined table gives a general idea of the number of germs present in a sample of sweet milk, although the number may really vary from two or three hundred to as many million. It also illustrates the variations which may occur in the number of germs in milk of the same age due to differences in the amount of the original bacterial seeding, or starter, which the milk receives, these differences being probably increased in this case by the fact of the milk being delivered in bottles. The absence of any close relation between the number of germs and the atmospheric temperature is due to the fact that the milk was delivered without cooling, warm from the cow, and before its own temperature could be much affected by that of the atmosphere. All samples in this table were four hours old when plated, after which they were kept in protected flasks at a temperature of from 20° to 22° C. (68° to 71° F.) till the first appearance of curdling.

Date.	Atmospheric Temp.	Number Per C.C.	Curdling Commenced After Plating, in Hours.
1896.			
Oct. 6	54	30,100	24
" 22	56	798,000	22
" 23	44	451,500	24
" 30	39	45,000	24
Nov. 1	48	8,400	28
" 2	58	35,000	28
" 3	52	91,000	28
" 5	30	7,000	—
" 7	27	10,500	.

Nov. 9	31	7,000	—
" 19	35	340,000	24
Jan. 17	34	200,000	20
Feb. 28	34	254,000	28
March 5	48	608,000	12
" 16	39	226,000	28

The next table is a record of observations made on the milk of two cows (September to January) the plates for enumeration of bacteria being prepared within an hour after milking. The first part of the table, where the numbers are high, gives the analysis of milk obtained without any precautions as to cleanliness, the milk being used for stock-feeding only. The excessive germ content was derived from the milk buckets, which were merely washed out with dirty trough water. In the samples from 11 to 14, inclusive, the buckets and strainer were well washed with boiling water, but no other precautions followed. The remainder of the table shows what may be considered the unavoidable infection (for the two cows in question) under practical milking methods. The flanks and udders of the cows were well brushed, the buckets thoroughly cleansed with boiling water, and the milker instructed in regard to personal cleanliness. The great improvement in the keeping quality of the milk in this case coincided with a greatly diminished bacterial content. The figures in the third column show the age of the milk at the time when souring or other peculiarity in taste was first detected. The + sign indicates that the milk was still good when the last observation was made; the — sign that it had soured or spoiled before the observation was made. The milk samples were kept at a temperature of from 20° to 22° C.

No.	Number Per C.C.	Age When Souring Detected.
1	2,114,000	—
2	2,911,000	—
3	3,612,000	24—
4	525,000	24—
5	700,000	24
6	300,000	28
7	1,428,000	28—
8	1,519,000	28
9	1,365,000	28
10	49,000	48
11	1,540	72
12	19,740	48+

13	23,800	48+
14	1,540	48+
15	1,750	48
16	4,200	48
17	1,470	48+
18	3,360	48
19	3,780	48
20	4,620	72+
21	4,340	60
22	5,600	48
23	3,710	36
24	5,880	84
25	4,900	48
26	5,460	48+

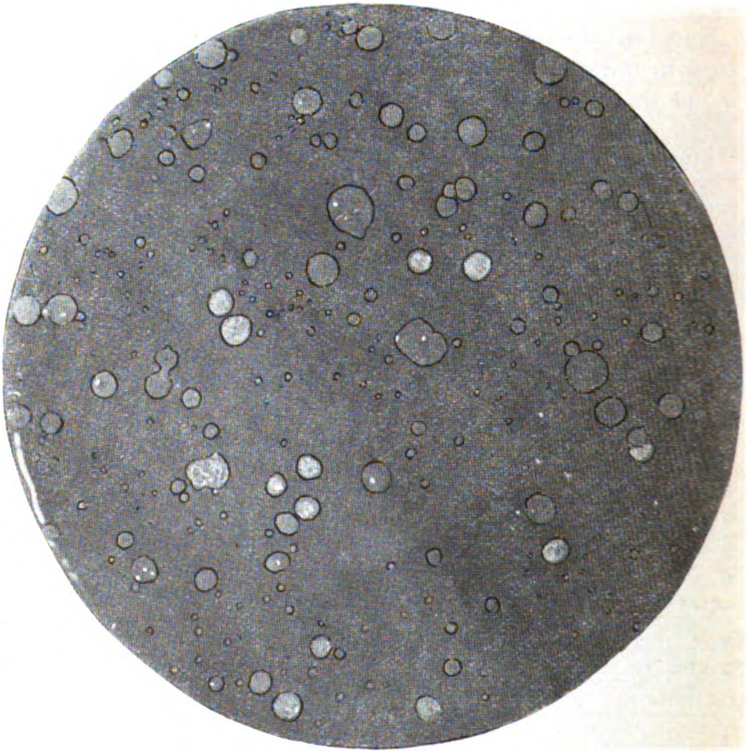


FIGURE 1. (From Photograph.)

Agar plate seeded with 0.001 c.c. fresh (impure) milk. It shows the number of bacteria in about 1·40 a drop. Number 526,000 per cubic centimeter.

A noticeable feature in the decomposition of milk, obtained with unusual precautions as to cleanliness in the buckets or vessels in which it is received, is the occasional occurrence of other forms of deterioration rendering the milk unpalatable before souring begins, but not affecting its appearance. Some of the samples examined, for instance, acquired a taste recalling that of ripened cheese, some became bitter, and others had the peculiar taste of milk kept sweet for an unusual time by cold.

In rare cases, when kept in closed flasks, curdling did not occur at all. These modifications seem to show the absence or tardy development of the common milk souring bacteria.

The greatly increased period during which milk can be kept sweet, when the necessary precautions against excessive bacterial infection are understood and acted upon, has been noticed in all recent work in dairy bacteriology. The practical bearing of this fact in the handling of milk needs no explanation.

Milk for Infants. It is now well-known that some of the intestinal disorders of infants nourished on cows' milk are occasioned or aggravated by the bacteria of milk, although the milk used may be apparently good and wholesome for older children and adults. It is supposed that the most harmful bacteria in this respect are those which gain entrance to the milk in dirt particles dropping from the sides and udder of the cow, really intestinal germs, rather than the milk souring species. These feces germs are not rapid sourers, and consequently may be numerous in milk long before souring begins. Milk to be used for infant food, therefore, unless sterilizing is adopted, should be obtained with the greatest care to avoid this source of infection; it should be rapidly cooled and kept cool till used; only fresh milk is admissible for this purpose. In general the sterilization of the milk, as described later, forms the best safeguard.

Unusual forms of decomposition of milk, often spoken of as "fermentations," are occasionally seen in dairies and factories. Among these are red, and blue milk, bitter milk, ropy milk, etc., most of which are of rare occurrence. They are due to the unusual preponderance of certain species of bacteria, not commonly occurring in milk or occurring in such small numbers that their effects are ordinarily imperceptible. Little is known of the special source from which these germs are derived. Bitterness in greater or less degree is found in old cultures of many species of bacteria which grow in milk without curdling it. Probably most of these unusual milk "diseases" have their origin in germs derived from the excreta of the cow.

SOURCES OF BACTERIAL INFECTION.*

The importance of limiting the extent and variety of bacterial infection of milk is manifest from what has been said in reference to milk preservation alone. It becomes still more manifest when the bacteriology of butter and cheese making are considered, a part of the subject, however, which is beyond the scope of this bulletin. Bacteria being constantly present in the air, and on all exposed objects, it is plain that milk must be exposed to infection at all times and from all its environments.

Infection from the *milk duct of the cow* is probably never absent, but its importance is variously estimated by different investigators. The number of germs found in milk obtained without exposure to outside infection has varied so greatly in the few tests recorded that at present it is hardly possible to arrive at any conclusion on the matter. Bolley† found in two cows numbers varying from zero to over one million per cubic centimeter, the lactic acid type of germs predominating.

A few observations made in my laboratory on the milk of two cows showed only a small bacterial content in such milk. The figures, as seen in the subjoined table, represent the number of bacteria per cubic centimeter in the first 20 cubic centimeters received into sterile flasks with precautions against external infection.

		Cow A.	Cow B.
Sept.	18, morning	2,000	140
"	18, evening	2,000	216
"	29	70	—70
Oct.	2	140	1,260
"	9	385	35

Besides these samples a considerable number were plated in order to determine the action on milk of the bacteria inhabiting the milk ducts. Of four species studied all were micrococci; three produced no apparent change in milk, and only slightly or not at all affected its reaction. None were favored in their growth by the addition of sugar to the meat infusion culture media. The common (rapid) milk souring germs were never found. A species quite frequently present in the teat ducts of one cow and absent in those of the other is that illustrated in Plate I., and of which the biological description is given later. Although when seeded in pure culture to test tubes of sterile milk this germ produced curdling with acidity in from three to four days at room temperature, the milk samples from which it was obtained either curdled after a much longer interval or did not show this change at all, indicating a possible difference in its curdling power on raw and on cooked milk.

---

*The word infection, frequently used in this bulletin, refers merely to seeding or transference of bacteria from any source into milk. Neither "infection" nor "bacteria" have any necessary connection with disease.

†North Dakota Experiment Station, Bul. 21.

The species that may be found within the teat canal, and probably within the discharging ducts of the gland, are, no doubt, subject to wide variety in different localities, being dependent upon external infection. All species that may gain entrance are not alike capable of maintaining their foothold. This is made manifest by a test made with one of the milk souring organisms described in Part II. Half a cubic centimeter of a glucose-buillon culture was injected through a milk tube into the milk cistern at the base of one teat shortly after milking in order to test its permanency of occupation and its power of curdling milk within the gland. This species grows and curdles milk equally well with and without the presence of oxygen; at 37° C. it curdles milk in tubes within twelve hours. (Its growth at 39° C. has not been tested.) This injection caused no disturbance in the function of the gland, and no curdled milk was passed. Three days later the number of germs (22,800 per c.c.) in the first milk of this teat was much in excess of the usual number, but the excess was not due to the species injected, but to a form not hitherto seen, which did not curdle milk. The species which was injected was not found on the plate. Two weeks after the injection the milk from this teat contained the usual small number of bacteria, and the species injected was not present; the milk, in fact, collected in a sterile flask did not curdle at all.

The passage of small fragments of curdled milk, a not very uncommon occurrence, is sometimes dependent upon a localized inflammation of the udder; in other cases it may possibly be a consequence of the presence of rapid milk curdling germs within the milk cistern, without any disease. A contagious form of udder disease dependent on bacteria, and accompanied with the passage of clotted milk, is also known. In all these cases this milk should be rejected as long as the condition lasts.

Infection *during the milking* is generally the most obvious of all sources. It is manifested by the particles of hair, dirt, excrement, straw, dust, and other forms of uncleanness which drop into the milk pail. Some of this filth is recovered on the strainer, but a large part is not, being broken up into minute fragments or dissolved in the milk. The particles of dirt which often form the greater part of this infection (really composed largely of intestinal discharges) swarm with bacteria, hence infection from this source may be the largest of all. There is also, here, the greatest variety of species, giving rise to the most varied forms of decomposition in milk. The probable influence of intestinal germs in producing harmful products in the milk has already been alluded to, but the common type of rapid souring and curdling germs have not been found. These, however, seem to be at least occasional inhabitants of the skin, and obtain entrance to the milk with the loose hairs dropping from the udder and flanks.

It is evident that the amount of bacterial infection from this source will depend chiefly upon the milkman's appreciation of the value of cleanliness in milking. With care it may be comparatively insignificant, while, on the other hand, with slovenly and careless methods it may be enormous. Its effects in the latter case become manifest in the rapid spoiling of the milk, its unwholesomeness from an hygienic standpoint, and in the quality of butter and cheese prepared from such milk.

Infection *after milking* includes all bacterial seeding which the milk receives from buckets, strainers, cans and other vessels used in storing milk, either at the farm or dairy, in milk depots, or in the household. It also includes germs deposited from the atmosphere, chiefly from dust-laden air of rooms. Compared with the amount of infection from unclean vessels, air infection is unimportant. Milk standing in an open bucket may receive from the air a few thousand germs in an hour, but every drop of old milk remaining in that bucket from the previous milking will contribute, in summer weather, a seeding of over twenty million germs. The bacteria derived from unclean vessels are usually those more especially concerned in milk souring. They represent the species especially adapted for growth in this medium, and those which most rapidly produce the ordinary form of milk curdling. Hence, in reference to the keeping quality of the milk, this appears to be, ordinarily, the most important source of infection. This is so on account of the difficulty, often little appreciated, of sufficiently cleansing the buckets, cans, bottles, etc., used for the reception of milk. Ordinary or apparent cleanliness in this case is not sufficient to insure even reasonable freedom from the germs of the old milk unless it has been obtained or supplemented by the aid of heat. The heat necessary for the destruction of these milk souring germs is not great. A momentary exposure to the temperature of boiling water, or longer exposure to lower temperatures, will, in general, insure their destruction, but neither of these conditions are fulfilled by the common practice of merely rinsing with a small quantity of hot water.

METHODS OF PRESERVING MILK.

The preservation of milk, in the sense in which the term is here used, that is, increasing the period during which it remains sweet and palatable and avoiding changes which may prove harmful to the milk as an article of diet, or impair the quality of butter and cheese which may be prepared from it, depends entirely, as may be inferred from what has been already said, upon the success with which bacterial multiplication can be controlled. Omitting the use of chemicals, which are inadmissible in dairy practice, the methods by which this control can be effected may be considered under the three heads: Cleanliness, cold, and heat.

Cleanliness in all stages of milk handling hardly needs to be further insisted upon after what has been said in regard to bacterial infection. Its importance is now recognized, in a general way, at least, by most dairymen, although some have not yet learned this primary lesson in milk handling. Cleanliness in milk handling, like cleanliness in surgery, implies much more than the mere avoidance of visible impurities. Milk cans, for instance, may appear to be clean when they are merely rinsed out with cold water, while in reality they are literally swarming with bacterial life. The methods which may be adopted in order to obtain the greatest degree of cleanliness can be inferred from what has been said of the principal sources of milk impurities. A few general suggestions only need be given.

The impurities received during the milking can be greatly diminished by thoroughly brushing the sides and udder of the cow, by cleanliness on the part of the milker, and by the avoidance of dust in the stable. Russell,* by figures of bacterial enumeration, shows the great diminution of infection which may be obtained by not only brushing but also washing the udder and flanks of the cow. Washing, it need hardly be said, is a necessity when the udder becomes fouled. In order to avoid these impurities, some trials were made of the utility of protecting the milk during milking by suitably arranged sheeting. A cloth fitted to the udder with holes for the teats was supported by a bandage over the back; from this a hood coming down over the pail with holes for the milker's arms afforded complete protection. The method proved a success so far as obtaining pure milk was concerned, but of course was attended with some inconveniences. Some modification of the usual wide-mouthed milk bucket has also been rightly suggested as an aid in limiting impurities at this stage.

*Dairy Bacteriology, p. 46.

Infection of milk from the vessels of various kinds used for holding it, is obviated, as far as this is practically possible, by the employment of heat. In well appointed dairies and creameries this is most efficaciously applied by the use of steam, but, ordinarily, hot water is employed. The latter is sufficient for the destruction of the common agents of milk souring if properly applied. Its use must be preceded by a thorough cleansing, especially of the joints or crevices where old milk is liable to collect, and it must be used as nearly at the boiling temperature as possible. One or two minutes complete exposure of all parts to water at this temperature is sufficient. With water at lower temperature its action must be more prolonged. Where bottles or jars are used for storing or delivering milk they can only be properly prepared for use by complete immersion, along with rubbers and cover, in water, which must be raised to 80° C. (176° F.) at least. Unless prepared in this way this method of milk delivery is the least desirable of all.

An important and often inconsidered agent in milk souring is the strainer, whether this be of wire gauze or cloth. The larger particles of dirt usually dropping from the body of the cow which are caught on the strainer become broken up and washed through with each successive bucketful poured into the can. Strainers therefore should be cleaned or changed during milking whenever dirt begins to accumulate in them. Cloth strainers require not only to be washed, but must be immersed in boiling water after use.

Cold is generally obtained in dairying by the use of water. The object of cooling milk is to limit the rapidity of bacterial multiplication. Generally speaking the growth of these organisms increases in rapidity as the temperature rises until the maximum rapidity of growth and, consequently, the most rapid souring of milk is reached at the temperature of the hottest summer weather. At temperatures below 15° C. (59° F.) there is comparatively little growth of milk souring germs. This fact forms the basis of the use of cold in temporarily preserving milk. Milk leaves the cow at a temperature favoring rapid bacterial multiplication, hence the general practice is to cool it at once to as low a temperature as circumstances permit. Where a temperature of 60° F. can be obtained in summer by the use of running water this is much the cheapest and most convenient method of cooling. The lower the temperature can be kept subsequently the longer the milk will keep.

Heat is the most effective agent in milk preservation, its effects depending on a destruction of the bacteria, not on a mere restriction of growth. In practical dairying heating of milk to increase its keeping qualities is but little employed. This method finds its chief application in the household, and there, as a rule, only in connection with infant feeding. Milk which has been heated in the manner described below not only remains sweet much longer than raw milk, but is deprived of any dangers resulting from the possible presence of harmful or disease producing germs. Heating of milk is indicated in the household in cases where the milk is suspected of being impure from improper handling or of coming from insanitary stables or milk depots. It is especially indicated in infant feeding under all conditions, but in summer more than in winter and in the city more than in the country. Two apparatus representing the methods employed in the heating of milk are here illustrated. Figure 2* shows a simple form which is in common use. The bottles being filled with milk are set in the bucket filled to the same level with water, and the water heated to the desired temperature which must be determined with a thermometer. Various degrees of heat have been recommended, the effect produced by any given temperature depending upon the period of exposure. For the destruction of the common milk souring organisms an exposure to 60° C. (140° F.) for fifteen minutes seems to be sufficient, but the milk itself must reach that temperature and not the water only. Generally 70° C. (158° F.), with fifteen to twenty minutes exposure, is

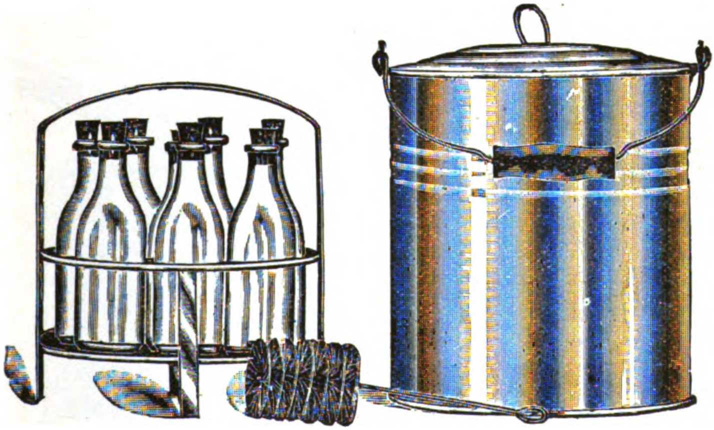


FIGURE 2.

---

*For cuts of figures 2 and 3 we are indebted to Henry Heil Chemical Company, St. Louis, by whom these articles are made and sold.

recommended in order to secure safety from the possible presence of disease germs which, in rare instances, have been found or suspected in milk.

In the steam sterilizer illustrated in Figure 3, which is the common form used in this country, the milk is subjected to about the temperature of boiling water. Free steaming is continued for at least twenty minutes with the size of bottles illustrated. Whichever apparatus is used the bottles, when the heating is completed, are removed and set aside until cool enough to be immersed in cold water without breaking. They should then be rapidly cooled and kept cool till used. Milk thus treated seldom sours in the usual way, but will undergo other changes due to forms of germ life which are not destroyed by a single heating. For infants fresh milk should be used and prepared daily.*

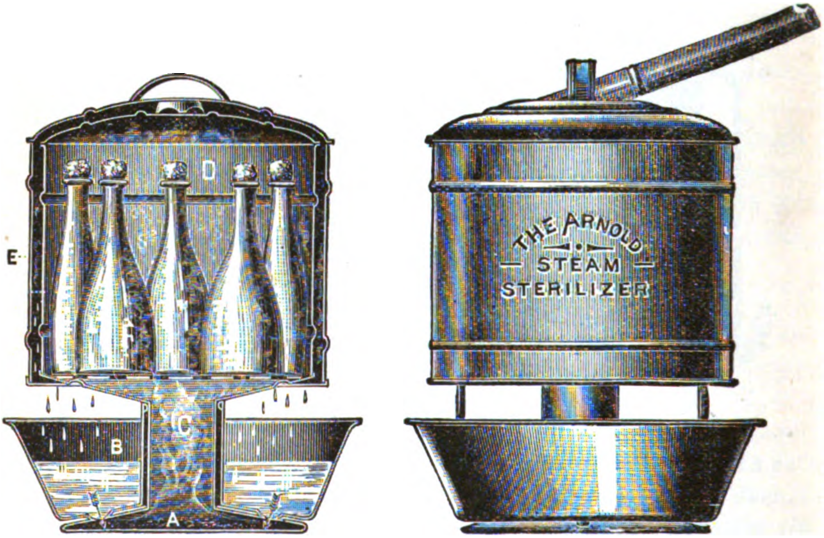


FIGURE 3.

---

*For information in regard to the proper preparation of cows' milk for infants, with details of the methods of pasteurization and sterilization, etc., see Starr: *Hygiene of the Nursery*.

Part II.

RESEARCHES ON THE BACTERIA OF SPONTANEOUS MILK CURDLING.

The most obvious change which ordinarily takes place in milk, as is well-known, is souring and curdling, in which the casein of the milk is precipitated by the acidity produced through decomposition or fermentation of the lactose by the growth of bacteria. Under ordinary conditions this change is so common that its absence might naturally lead to the suspicion of adulteration by some preservative material. It may also be further stated as a matter of daily observation that the time which elapses before this change takes place depends upon the temperature to which the milk is exposed, being shorter the more nearly the temperature approaches that of summer heat. It is well-known to practical dairymen, though perhaps less generally appreciated by others, that this matter is also largely dependent upon the degree of cleanliness with which the milk is handled. The explanation of the influence of these two factors upon milk preservation has already been given.

Milk, being exposed to bacterial infection from such varied sources, and forming, as it does, a favorable medium for bacterial multiplication, must naturally harbor a great variety of species when it reaches the table of the household.

The usual decomposition of milk is really a result of the growth of all the varied species multiplying in it, each species producing in greater or less amount its own peculiar decomposition products. The preponderance of any one species will depend upon its greater adaptability for growth in this medium, its power of inhibiting the growth of other species, and also largely upon the amount of the original seeding or "starter" with that species which the milk receives. Those species which are especially suited for growth in milk, which have the power of predominating in numbers over the others which may be present, will, in the ordinary methods of dairying, also furnish the greatest volume of infection. It can be inferred from this that in the constant use of the same vessels, storerooms, etc., in dairy farming one species or group of organisms may become the predominant and constant agent of milk fermentation in a particular dairy.

The curdling of milk by bacterial growth may occur not only, as stated, by the acidity developed through fermentation of the lactose, but also by the formation of bacterial enzymes, resembling in the latter case the curdling of milk by rennet in cheese making. In spontaneous curdling the process seems to be almost invariably due to the former cause, that is, to organisms which have as the most prominent feature of their growth the fermentation of the lactose, the various modifications which often occur in the process being the result of other accompanying germs. The term, "lactic ferments," has been applied to these common milk souring organisms; they belong to what have been designated the lactic acid group of bacteria.

In the earlier days of bacteriology it was believed that the property of fermenting lactose, and thus producing the familiar change in milk, was the especial attribute of one particular species to which the name *Bacterium lactis* was given. It is now known that very many species have this property of producing acidity in milk; a lesser number produce both acidity and curdling. The curdling which takes place with many such germs in artificial cultures occurs often after a considerable length of time, and in many cases is not a simple acid precipitation of casein.

In the spontaneous curdling of milk such as regularly occurs, for instance, in the product of dairy farms, the milk acquires a sour taste, or "turns," and a few hours later coagulates into a soft, solid mass, with separation of a relatively small quantity of clear or slightly milky fluid. It emits only the faint and not offensive odor characteristic of soured milk. This may be called the typical lactic fermentation. It is due to the growth of a single species of bacteria, or, it may be, to several species with similar fermenting properties. Modifications of this process, or later changes which may occur, depend upon the multiplication of germs associated with the common milk souring organisms or lactic ferments.

In Europe a number of bacteria have been described as the common agents of milk souring in different localities. Of these may be especially mentioned the *Bacillus acidi lactici* of Hüppe, found constantly by this author and others in soured milk in Berlin and Würzburg; and an organism described by Günther and Thierfelder **(Bacterium Guntheri)*, also occurring in Berlin soured milk. In this country, no one organism, so far as I know, has been especially associated with the spontaneous milk souring. Conn† notes the absence in the milk and cream which he examined of the *Bacillus acidi lactici*, and states that the members of the lactic acid group of bacteria which he found were usually short, nonliquefying, nonsporulating, ærobic bacilli.

---

*Archiv für Hygiene XXV, 164.

With the aim of determining the species more especially concerned in the acid curdling of milk in this locality, and the source of these germs, some researches were undertaken during the fall and winter. The usual methods of isolating bacteria were employed, plates being made with ordinary nutrient gelatin, neutral or feebly alkaline in reaction. The resulting colonies were then tested as to their action on milk by direct seeding from the plate into tubes containing sterile milk, which were kept at a temperature of from 20° to 22° C.

Only those species which produce rapid souring and curdling of milk were further investigated.

In the earlier tests, which were made with small quantities of milk received directly from the cow into sterile vessels and kept, either covered or uncovered, at the temperature of the laboratory till the desired change occurred, a number of pigment forming germs were obtained which, at room temperature, produced curdling with acidity in sterile milk after a period of from three to seven or eight days. Milk which was thus obtained was found to remain apparently unchanged for an unusual length of time and in some cases, when protected by sterile cotton plugs, did not undergo any change in its physical characters at all although always becoming unpalatable if kept over a week. In those samples which did sour and curdle the appearance of the milk was not such as we generally find in milk as usually obtained, showing that the true lactic ferments were not present. Three of the species most commonly found in such milk were studied. They were all micrococci growing freely on all the usual media with the production of a yellow pigment of varying shades. Their growth was not favored by the addition of sugar to the culture media and no gas and only a slight degree of acidity were developed. They curdled milk slowly and the clot subsequently underwent partial solution. These therefore were not representatives of the ordinary milk sourers, but the frequent presence of these and other such germs in milk from all sources which was examined while fresh shows the complex nature of the usual milk decompositions.

Milk from Dairies. My investigations of dairy milk were confined to samples from four dairy farms during the months from October to March, two of these being in the neighborhood of the laboratory, from which numerous specimens were obtained, and two in remote parts of the State (Newport and Camden). From these latter only one sample each was examined. In the two latter cases the milk was obtained when already curdled; in the former it was either curdled when received or poured while yet sweet into sterile flasks plugged with cotton and allowed to remain at room temperature until curdling occurred.

---

†Third Annual Report of the Storrs School Agricultural Experiment Station.

It was found, as might be expected, that from all samples of soured milk several distinctly different species of bacteria could be isolated, the differentiation being easy enough from the mere plate and cover-glass examination. The seeding of milk tubes from the plate colonies allowed of a rough distinction of the species obtained into three groups according to their action on milk:

(1) Those that occasioned a rapid souring and complete coagulation.

(2) Those that produced a comparatively slow and imperfect curdling with abundant fluid, with or without acidity.

(3) Those that multiplied in milk without altering its physical properties, and either with or without acidity.

From all specimens of spontaneously soured milk which were examined representatives of the first group could be isolated. These, on account of the rapidity with which their characteristic action is produced and usually their preponderance in numbers in spontaneously soured milk, are to be regarded as the common or principal agents in effecting this change. Two representatives of this group are illustrated on Plates II. and III. The species illustrated on Plate II. and for which I have suggested the name *Bacterium lactarii*, since it cannot be identified with any hitherto described species, may be taken as the type of the first group or of the common milk souring germs which have been found in all samples of dairy milk examined. It is difficult to make a specific differentiation between the various cultures of members of this group which have been isolated from different samples of milk. The gelatin plate colonies of these organisms are little characteristic. They are of small size, with circular outline and smooth, regular margins. Colonies with these characters were often found to differ slightly from each other in their size, degree of opacity, and the presence or distinctness of concentric rings. As a rule milk tubes were seeded from all colonies which showed even these slight differences, but the further study of the cultures thus obtained did not allow of any distinction into separate species. The slight differences which were noticed or suspected, especially in the appearance of the colonies on gelatin plates, in their morphology, or in the extent of their growth on agar, are hardly greater than can be seen in different cultures of the same origin. This is the result arrived at from a comparative study of many cultures obtained from different samples of milk, in which the plate colonies led to a doubt of their identity. The difficulty of specific differentiation is increased by the feebleness or entire absence of growth of these germs on some of the common culture media. The biological description given of the bacterium of Plate II. applies therefore to the members of the above group of common milk souring organisms, the question of their specific identity being left unsettled.

Besides the examinations of the milk of single cows referred to above, in which the samples were obtained with unusual care to avoid infection, a number of samples of milk were examined obtained from households in which only a single cow furnished the supply. The experiences which I have had in these examinations, somewhat limited in number, seem to show that in the case of milk obtained from a single cow there is less constancy in the presence of any one souring organism than in the case of milk from dairy farms. This is often indicated without any bacterial test by the longer preservation of such milk. The same organisms in some cases were found in this milk as in dairy milk; in other cases several species of slow curdling powers were alone isolated in which the resulting clot was not typical of the lactic fermentation. From one sample of this milk the germ figured on Plate III. was obtained. It resembles the other members of this group in all its cultural features but differs markedly from these in its morphology when grown in milk and in glucose-bouillon. The difference consists in its slightly larger size, its greater tendency to the formation of chains, and in the marked tendency to early segmentation, giving the individual elements the characteristic hemispherical appearance shown in Figure 6. These differences disappear when the culture on agar is examined. Here its morphology is indistinguishable from that of other members of this group.

The main features by which these milk souring organisms are characterized may be briefly summarized as follows: They are ovals, or short, round-ended rods (Genus *bacterium*, of Lehman), nonmotile and nonsporulating. Growth is feeble on the ordinary nutrient media, absent on potato, Löfflers serum, and asparagin solution (albumin-free). Lactose and glucose in nutrient peptone bouillon is rapidly fermented without gas evolution. Milk is quickly coagulated with strong acidity, and with separation of only a few drops (in test tubes) of clear fluid, which does not increase in older cultures. The clot or curd is firm and not discolored, and does not undergo any later change. The germs are ærobic and anærobic, milk being curdled alike in both cases. The chemical products resulting from their fermentation of lactose have not yet been determined.

Some features in connection with the biology of the common milk souring organisms, as represented by the *Bacterium lactarii* are of interest on account of their bearing on practical dairying.

Besides its common occurrence in soured milk, this germ (or its allies) has been found only in sterilized milk, curdled by hairs plucked from the udder of the cow. It was not found in milk curdled by the addition of the intestinal discharges of the cow (several tests), nor in hydrant water.

The following tests show its power of resistance to heat. In making these tests tubes of nutrient bouillon containing glucose, and others containing sterile milk, were heated in the water bath to the desired temperature, seeded with a loop of a fresh culture in the same medium, and returned to the bath for the time given, when they were quickly cooled in running water. The tubes were then kept under observation for some days, to see whether any growth occurred. Growth is quickly manifested in glucose bouillon by turbidity, in milk by its coagulation. It was found that these germs are destroyed by:

One minute exposure to	80° C.
Three minutes exposure to	75° C.
Five minutes exposure to	70° C.
Fifteen minutes exposure to	55° C.

They were not killed by:

One minute exposure to	60° C.
Five minutes exposure to	65° C.

Pure cultures in milk die in from two to three weeks at room temperature, evidently by the action of the acidity developed, since agar cultures retain their vitality for at least six weeks.

They were not destroyed by insolation (in dry condition) during five hours on three successive days (temperature 35° C.), nor by one month's drying.

Milk Curdling Properties. In estimating the rapidity of milk curdling in the test tube, it is necessary to take account of the number of germs transferred; a large seeding, at the same temperature, produces earlier curdling than a small. When 10 c.c. of sterile milk is seeded with one loop of a fresh glucose-bouillon culture, the usual time of complete curdling at 20° to 22° C. is from twenty-four to thirty hours; at 37° C. it occurs within twelve hours. The number of germs present in milk soured by pure cultures of this species before curdling occurred was found by several tests to vary from five hundred million to one thousand million per cubic centimeter. The acidity present in this milk while still fluid was represented by 0.5 c.c. of deci-normal soda solution to the cubic centimeter; the serum of a two days old clotted milk culture by 0.875 c.c.

Cover-glass preparations from the fluid and curd of pure cultures in milk of some days growth show the number of germs to be small as compared with the numbers found in spontaneously curdled milk of the same age. The acidity produced evidently inhibits the growth of the lactic organisms, but allows the development of the other species present.

Milk purposely infected with the *Bacterium lactarii* in small amount and with the excreta of the cow in comparatively large quantity, exhibited the change due to the feces germs rather than to the lactic organism. With an alkali producing bacillus from hydrant water the resulting change might be said to be intermediate between the effects of each singly. The medium became acid, but the clot subsequently underwent liquefaction. It would appear from these and other observations of the same kind that the effects of the common milk souring germs on milk may be delayed or modified by a relatively large seeding with other organisms having a different effect. When the seeding with the milk souring organism is large the effect is at first nearly the same as in pure cultures, but later changes occur.

The germs described by Günther and Thierfelder* and by Leichmann† seem to have many points of resemblance with that here described as *Bacterium lactarii*. A comparative study of these germs might, indeed, show a resemblance close enough to justify their admission as one species.

Conclusions which may be drawn from these observations hardly admit of general application, in so far as the rapidity and character of spontaneous milk changes must largely depend upon the care and skill with which the milk is handled. Different bacterial forms may also possibly prevail in dairies in different regions of the country from causes independent of methods of milk handling.

---

*Archiv für Hygiene, XXV., 164.

†Centralblatt für Bakteriologie, XVI., 826. *Ref.*

BACTERIAL ANALYSIS.

PLATE I.

NAME. **Micrococcus uberis.**

OCCURRENCE. In the milk duct of the cow.

MORPHOLOGY. Cocci of medium size, arranged mostly in pairs; single forms and irregular groups occur, and, rarely, short chains of four to six. In chains the longer diameter of each element is across the long axis of the chain. They are nonmotile and readily stained by aqueous solutions as well as by the method of Gram.

CULTURAL CHARACTERS. Growth occurs with about equal rapidity at 20° and at 37° C. They are ærobic and feebly anærobic.

Gelatin plate. In twenty-four hours the colonies are visible as white points; x60 they show a greenish yellow tinge with ragged edges. Fluidification occurs early in the surface colonies, which, by the third to the fifth day, if not crowded on the plate, attain a size of 2 to 4 mm., with a central area and peripheral zone separated by a clear space (Fig. 5).

Gelatin tube. In stab cultures there is early fluidification forming at first a funnel shaped depression, which, in ten or twelve days, extends across the tube, its two surfaces then becoming parallel. The fluid is slightly turbid and without surface pellicle; in five weeks growth about half of the medium is fluidified. In the depth a smooth white track appears in one day and does not increase in size.

Agar tube. Surface growth is free, white, and spreading over most of surface below, above limited to wire track. It is slightly raised with smooth, moist, glistening surface.

Bouillon. In twenty-four hours, at room temperature, there is slight cloudiness which does not increase, but is persistent. There is no surface pellicle. Sediment white and thread-forming on shaking.

Potato. Free growth limited to wire track; raised, white, granular surface. Surface of medium not discolored. Growth ceases in a few days.

Milk. At 20° C. it sours and curdles after four to five days, with considerable fluid which increases later at the expense of the curd. At 37° C. there is free growth, but no curdling occurs. After long incubation a thickening of the fluid alone appears.

Glucose-bouillon. In the fermentation tube a slight cloudiness in the open arm in two days at 20° C. which hardly increases, and, later, clears by sedimentation. No change occurs in the closed arm. No gas.

PLATE II.

NAME. **Bacterium lactarii.**

OCCURRENCE. Constantly in spontaneously soured milk from dairies.

MORPHOLOGY. Ovals, single and, more commonly, in pairs. Short chains of four or six sometimes occur in milk and glucose-bouillon. When in pairs each element is somewhat square at the attached end and rounded, or occasionally pointed at the other (Fig. 5). When segmentation begins the length is about 2.5μ, the breadth 1μ. Single elements measure about 1.5μ by 0.8 to 1μ. The size and shape are not subject to much variation in the different media, longer unsegmented rods hardly ever occurring. Involution forms have not been seen. They are non-motile, do not form spores, and are stained by Gram's method and by the usual hydro-alcoholic solutions.

CULTURAL CHARACTERS. Growth occurs at 20° C. and at 37° C. Lactose fermentation proceeds more rapidly in the incubator, but on nutrient agar little difference in growth due to higher temperature is observed. The germ is both ærobic and anærobic; growth and sugar fermentation does not seem to be favored by the access of oxygen.

Gelatin plate. In twenty-four hours at 22° C. colonies are just visible points; they have then a maximum diameter of 0.15 mm.; x100 they are seen to be quite circular with regular, well-defined margin, and finely granular. In four days they attain a diameter of 0.25 mm.; x100 they are almost homogeneous except at the periphery, where a granular translucent zone can be seen, the junction of the thicker central area with the peripheral thinner zone being generally indicated by a faint ring. No further change or increase of size occurs. Surface colonies, as a rule, do not differ in size or appearance from those in the depth. A few, however, spread out on the surface of the medium, the colony then showing a central, nucleus-like, dense aggregation of varying size, with a wider translucent granular zone around; the margin is less regular than in the deep colonies; these may attain a diameter of 0.5 mm.

On 2% lactose gelatin the colonies have the same appearance and size as on ordinary nutrient gelatin.

On lactose-litmus gelatin they resemble the above, but have a faint red or pink color when seen on a dark background.

Lactose-gelatin with Chalk. On this medium the colonies are larger and more opaque, circular and regular in outline. They reach a diameter of half a millimeter.

Gelatin Tube. The growth is small. It occurs all along the needle track in colonies which are isolated near the bottom, coalescing above. After a few days growth ceases. A thin, colorless surface growth of small size can be detected with the lens. There is no fluidification.

Agar tube. Growth feeble and about the same at 37° C. as at room temperature. It is visible in twenty-four to forty-eight hours as a faint granular appearance of the surface of the medium along the inoculating streak; with the magnifier this can be seen to be due to small colorless colonies. By transmitted light the growth appears white and opaque. Later it becomes more distinct and the colonies, mostly remaining separate, appear denser and more opaque. A yellowish white sediment appears in twenty-four hours and increases; condensation water remains clear. After a few transfers on this medium a somewhat larger growth occurs.

On the surface of *glucose-agar* the growth is larger than on ordinary nutrient agar, but otherwise the same.

Diffused in *lactose-litmus agar* ("Schüttelkultur") the colonies appear all through the medium, which acquires a pink color, beginning at the surface and extending to the bottom of the tube. No gas.

Bouillon. Fluid remains clear; a slight sediment can be seen on shaking the tube.

Glucose-bouillon (2%). At 20° to 22° C. dense turbidity within twenty-four hours, with large scattered sediment, which diffuses through the fluid on shaking; there is no surface pellicle, and the medium begins to clear in thirty-six hours; it is strongly acid, without odor.

In the *fermentation tube* at 20° C. a uniform turbidity appears within twenty-four hours in both arms; later the fluid clears, the sediment adhering along the walls. No gas is evolved.

Saccharose-bouillon. As on ordinary nutrient bouillon.

Potato. Hardly a trace of growth.

Milk. Firm coherent clot in twenty to thirty hours at room temperature; within twelve hours in the incubator. A few drops of clear or flaky fluid separates from the clot. The latter remains in position when the tube is inverted. It undergoes no further change on keeping. Strong acidity, with faint sour odor.

Products of growth. Not determined.

PLATE III.

NAME. **Bacterium discissum.**

OCCURRENCE. In spontaneously soured milk.

MORPHOLOGY. Ovals occurring singly, in pairs, and in chains. Single forms are about one half longer than broad; dimensions about 1.5μ by 1μ. In milk short chains are common. In glucose-bouillon, chains are most abundant and longer than in other media. The individual elements of these chains are short ovals, sometimes nearly round, and many of them are traversed by a cross segmenting line without constriction, giving them the appearance of two apposed hemispheres; the two segments, however, frequently vary in size. (Fig. 6.) Agar cultures scarcely show these characters at all. On this medium the morphology is exactly like that of the *Bacterium lactarii*, but in size they are perhaps slightly larger. They are nonmotile and do not form spores. Usual stains; also by method of Gram.

CULTURAL CHARACTERS. These are in every way similar to those described for *Bacterium lactarii*, with the following exceptions, which, moreover, are hardly appreciable.

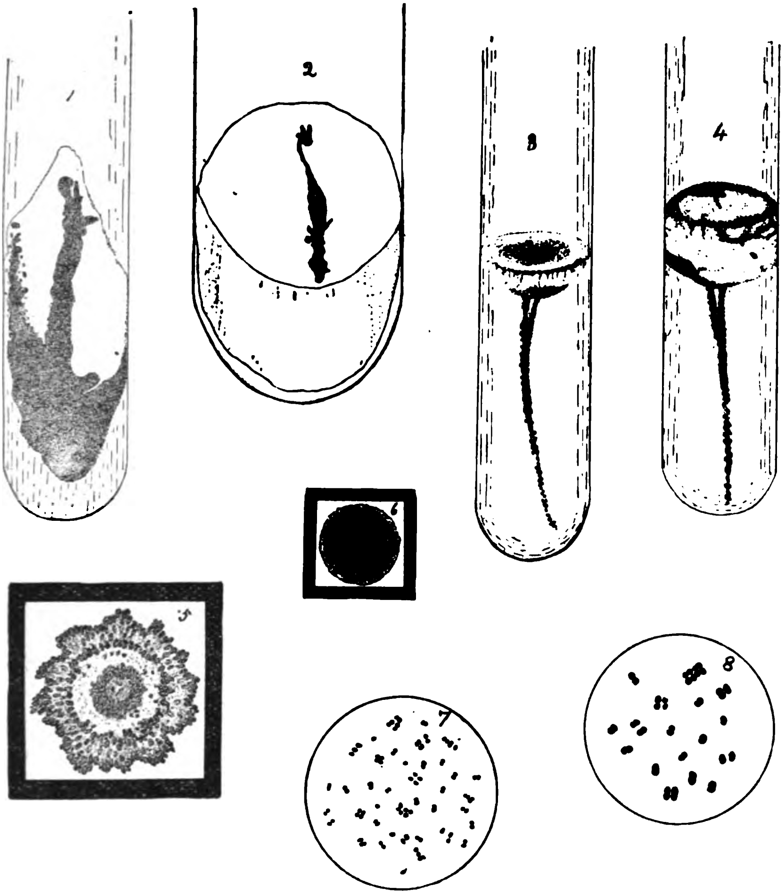
Gelatin plate. The ringed appearance of the colony is less distinct or absent, and the colony as a whole more homogeneous.

Agar tube. Growth is feebler.

Glucose-bouillon. Turbidity appears later, but is equally dense.

Milk. The quantity of clear fluid separated from the curd is slightly larger, especially when grown at 37° C.

PLATE I.*



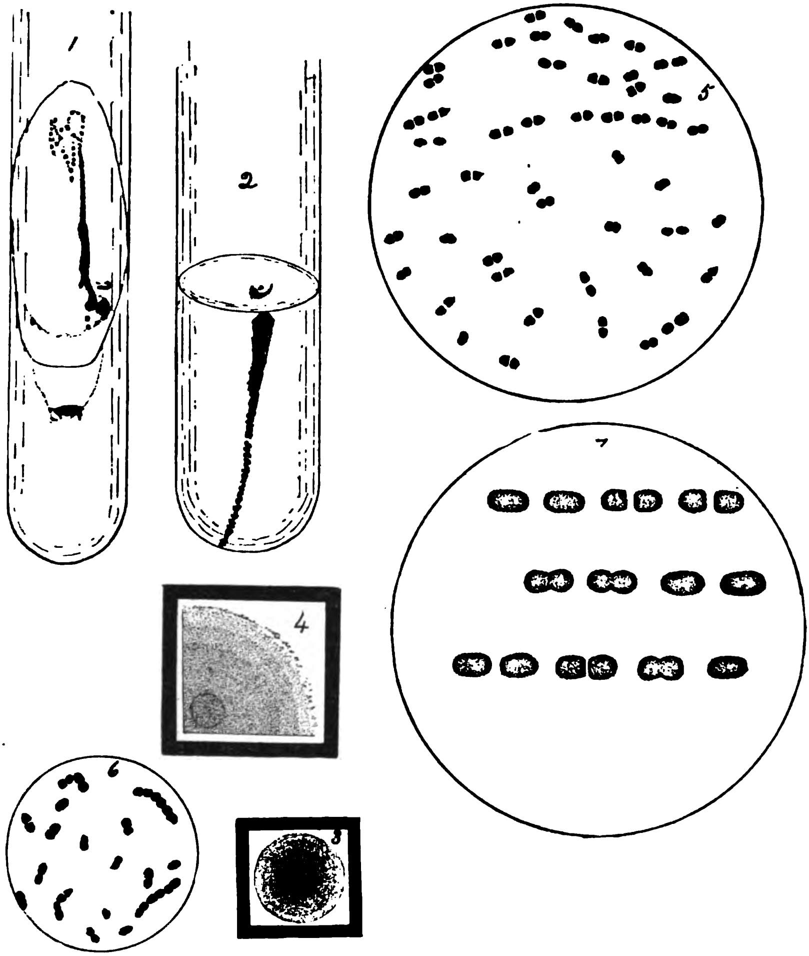
MICROCOCCUS UBERIS.

1. Agar streak culture; 1 week at room temperature.
2. Potato tube culture; 10 days.
3. Gelatin tube stab culture; 4 days at 22° C.
4. Gelatin tube stab culture; 2 weeks at 22° C.
5. Gelatin plate surface colony; 3 days at 22° C.; X7.
6. Gelatin plate deep colony; 2 days at 22° C.; X60.
7. Cover-glass preparation from bouillon culture; X600.
8. Cover-glass preparation (same as 7); X1500.

(Reichert. Oc. 4, Obj. 1-18, t. l. 160 mm.)

*Drawings for plates I., II. and III. by Miss A. Simonds.

PLATE II.

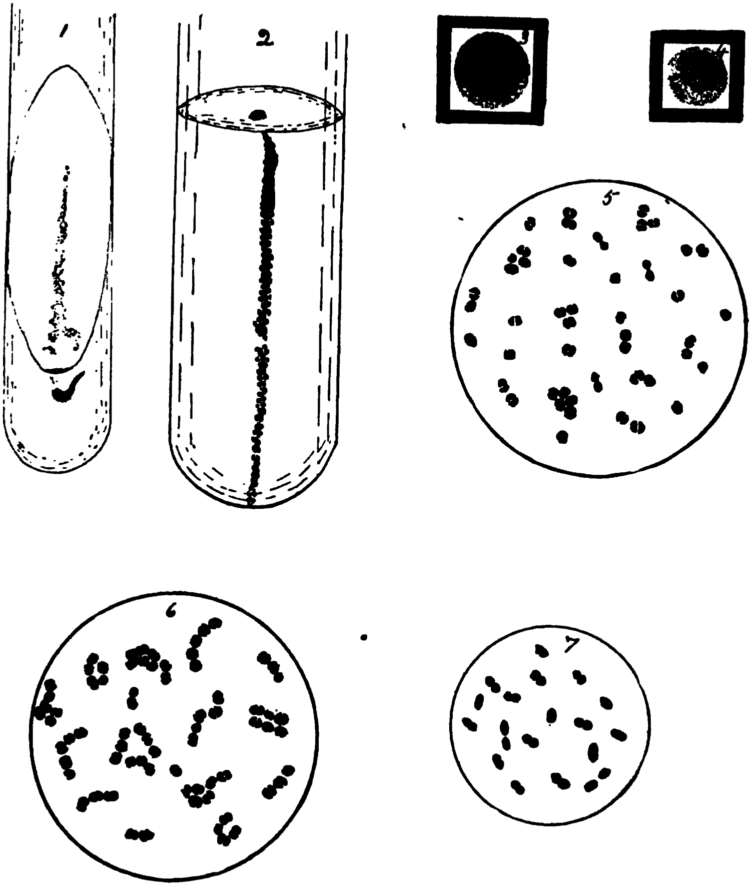


BACTERIUM LACTARII.

1. Agar streak culture; 2 days at room temperature.
2. Lactose-gelatin stab culture; 3 weeks at 20° to 22° C.
3. Gelatin plate deep colony; 3 days at 22° C.; X100.
4. Gelatin plate surface spreading colony; 4 days at 22° C.; X100.
5. Cover-glass preparation from 3 days milk culture; X1500.
6. Cover-glass preparation from 2 days glucose-bouillon culture; X1500.
7. Diagrammatic; showing growth and segmentation.

[*This figure being improperly placed (inverted) should be read from right to left.*]

PLATE III.



BACTERIUM DISCISSUM.

1. Glucose-agar streak culture; 10 days at room temperature.
2. Gelatin tube stab culture; 5 days at 22° C.
3. Gelatin plate deep colony; 6 days at 22° C.; X100.
4. Gelatin plate surface colony; 5 days at 22° C.; X60.
5. Cover-glass preparation from milk culture; X1500.
6. Cover-glass preparation from glucose-bouillon culture; X1500.
7. Cover-glass preparation from agar culture; X1500.

SOIL IMPROVEMENT.

BY R. L. BENNETT.

The most important question in farming in Arkansas is the cheapest and best methods for improving worn cotton soils. The clean culture for cotton, together with the long summers, have exhausted the soil, and the upland soils have in addition been badly washed and leached until frequently there is nothing left of them but the subsoil. The vital question with the farmer then, especially in the older settled parts, is the improvement and the restoration of these worn soils. The quickest, cheapest and most permanent methods for accomplishing that result is the thing desired. The questions upon which experiments have been made are:

1. What do the worn cotton soils need to increase their productiveness?

2. What is the cheapest, most durable and available form to apply nitrogen?

3. Are potash and phosphoric acid necessary on all worn soils for staple crops?

4. What is the cheapest and best form to applv them?

Some of the many and varied experiments that have been made during the past six years upon the questions above mentioned have but little value when taken separately; but when taken together, through several years of different seasons, they furnish some useful information on the proper method for restoring worn cotton soils. The experiments are reported in detail in the last pages of this Bulletin.

SUMMARY OF THE EXPERIMENTS.

1. Worn cotton soils need nitrogen, vegetable matter, better tillage, and better protection.

2. The cheapest, most durable and available form to apply nitrogen is vegetable nitrogen, in the form of cowpeas, cotton seed, and cotton meal.

3. One crop of cowpeas turned in the soil will furnish more nitrogen than is necessary for one crop of corn or cotton.

4. Most of Arkansas' clayey soils do not need an addition of potash and phosphoric acid for staple crops, if the soil's supply of those foods is

made available and increased and the soil water increased by thorough and continuous tillage and by rotation with cowpeas. The exception to this is the deficiency of available potash and phosphoric acid in the sandy pine soils of South Arkansas. On that soil it may be profitable to use potash and phosphoric acid to a limited extent, but only after first testing to ascertain that extent.

5. Kainit and acid phosphate, 13 per cent and 14 per cent available, are the best forms to purchase potash and phosphoric acid.

IMPROVING WORN COTTON SOILS.

The experiments indicate the following briefly stated practices for improving the worn cotton soils:

That the cheapest and best way to improve worn cotton soils is not by the exclusive use of commercial fertilizers containing nitrogen, potash and phosphoric acid; but to produce the nitrogen on the soil in cowpeas, thus adding to the soil the much needed vegetable matter and the nitrogen at the same operation and the least expense. The nitrogen thus supplied is in a durable form, which is so essential in Southern soils.

That proper and continued summer tillage increases soil nitrogen by promoting conditions favorable to the action of nitrifying organisms.

That cotton seed and cotton meal are the cheapest and best forms to buy nitrogen for fertilizing.

That it is rarely necessary to buy potash and phosphoric acid for staple crops when the soil's supply of those foods is increased by proper tillage before and after planting.

That thorough tillage increases the summer water supply, thus affording a better utilization of potash and phosphoric acid that are in the soil.

That the supplies of potash and phosphoric acid are increased in the soil when cowpeas are grown to produce nitrogen and vegetable matter; the cowpeas bring the potash and phosphoric acid from the subsoil to the surface soil.

That it is advantageous to promote and protect the above practices in soil improvement by winter protecting the soil with oats, rye or crimson clover; and if the soil is upland, it should be terraced to prevent leaching and washing; and that cowpeas should be turned in the soil in the fall.

EXHAUSTION OF NITROGEN AND VEGETABLE MATTER IN ARKANSAS SOILS.

The greatest need for the improvement of worn cotton soil is vegetable matter and nitrogen. The quantity of vegetable matter in a soil controls the quantity of soil nitrogen, so the loss of vegetable matter is also a loss of nitrogen. In the South, vegetable matter disappears from the soil very rapidly. This change is caused by the long summers, mild winters and frequent rainfalls, then, added to those destructive influences, is the clean culture for cotton and corn, continued without a rotation of cowpeas or other leguminous crop.

Cotton Seed and Cotton Meal for Nitrogen.—Whenever, after testing the matter, it is found necessary or profitable to buy nitrogen, the Arkansas farmer should always buy it in cotton meal, or crushed cotton seed, for the reason that it is far the cheapest and most durable form (being vegetable nitrogen) in which he can buy nitrogen. In addition to those advantages, his consumption of cotton seed and meal increases the market for his, or his neighbor's cotton seed, and, also, the money paid for them remains in his neighborhood instead of going to other distant regions, as it does when nitrogen is bought in other forms. The nitrogen of cotton meal is sufficiently available for the immediate use and needs of all staple crops and most truck crops. It is liberated very quickly when in the soil with proper temperature and moisture, but, as it becomes available gradually, it is consumed by growing crops, and is not leached as it is when applied in a readily soluble form. Cotton seed and meal contain an important amount of potash and phosphoric acid besides the nitrogen. The following table shows the fertilizing value and the market value of cotton meal nitrogen and other commercial forms of nitrogen.

Nitrogen.	Fertilizer Value.	Market Value.	Difference.
Cotton seed meal	$20 50	$19 00	$1 50
Nitrate soda	45 00	45 00	
Sulphate of ammonia	66 00	66 00	

Nitrogen alone is estimated in the meal. The potash and phosphoric acid in it are worth $4.65, which makes meal sell for $6.15 per ton less than its fertilizing value.

Should the Farmer Sell His Seed and Buy Meal.—The following table exhibits the present market value of meal in a ton each of seed and meal:

	Market Price.	Price per Pound.
Ton seed, pounds meal, 750	$ 7 00	.933
Ton meal, pounds meal, 2,000	19 00	.950

So at the present prices per ton, seed is sold for less than meal, and to that difference in favor of seed is to be added the fertilizing value of the hulls and the expense of hauling the seed to market and hauling the meal back.

Is Seed as Good for Fertilizing as Meal? is a question frequently asked. The nitrogen in uncrushed or unfermented seed is not in a condition to become available as readily as it is in cotton meal, but by crushing that difference in availability is removed.

Cotton meal and crushed seed, when used for fertilizing, will destroy the seed of the planted crop if put in contact with them.

Fermenting Seed.—The seed is fermented to kill the germ and to increase their availability as plant food. The common way of doing it is in heaps in the open air. But that is wasteful of nitrogen. The quantity lost depends upon the degree of decay to which they are permitted to go.

The cheapest way to destroy the germ is to apply the seed to the soil before it gets warm. The soil is then too cold for the seed to germinate. Later in the season this plan would not be advisable because the soil would be warm enough to germinate the seed.

The old way of composting is far too *expensive* to be profitable, and especially as there is no gain in fertility to the materials used in making the compost. Other methods are now practiced which accomplish the same results as were intended to be secured by the old expensive and "man killing" compost making and compost distributing. The main object of composting is to more thoroughly prepare coarse vegetable matter for use as plant food. This can be better done by putting it in the soil.

Crushed Seed.—Effective horse or steam power machines* are now made for crushing seed and some do admirable work. The expense of crushing seed is very reasonable. Perhaps only few farmers can afford to own a crusher for their own exclusive use, but a mill should be in every neighborhood as a community mill, and the owner could move it from place to place and crush seed for so much per ton.

---

*The following firms are makers of cotton seed crushers: Perryman & Co, Birmingham, Ala.; Cardwell Machine Co., Richmond, Va. The first named firm makes a mill that screens the meat from the hulls.

WHEN AND HOW TO USE PHOSPHORIC ACID AND POTASH.

As previously stated, experiments show that the Experiment Station soil, when thoroughly tilled and crops rotated, does not need either potash or phosphoric acid to be added to it for the use of staple crops. The soils that need potash and phosphoric acid fertilizers are the sandy pine soils of south Arkansas. They are naturally more deficient in those two plant foods than the more clayey soils of the State.

When it is found, after testing them on the soil, that potash and phosphoric acid can be purchased and used profitably, they should be bought separately, then mixed and applied to the soil in the quantity shown to be profitable in the trial tests. Perhaps the best form to buy potash is that of kainit, and it should contain not less than 13 per cent potash. Acid phosphate is the best form to buy phosphoric acid, and it should contain not less than 14 per cent available phosphoric acid. Of course the per cent of potash and phosphoric acid in the goods simply means that there are only those amounts in each 100 pounds. The other materials, which constitute the bulk of the kainit and acid phosphate, are of little or no value as a fertilizer. They are only dilutants for the potash and phosphoric acid. The term, Acid Phosphate, is used to mean rock phosphate treated with sulphuric acid.

Quantities to Use of Potash, Phosphoric Acid and Cotton Seed or Meal per Acre for Different Crops.—No rule can be given in reply to this question, except to say that chemical analysis shows that a certain quantity of potash, phosphoric acid and nitrogen are removed from the soil by certain crops, and those amounts can be taken as a basis for trial, using more and less of each, and the yield of the crops on the different plots where different quantities were used will show which quantity was a profitable amount, of that plant food on that soil and with that crop. Each crop and each soil requires a separate test to be made. It is plain that the farmer is compelled to experiment with commercial fertilizers in order to use them intelligently and profitably.

The following table shows the pounds of potash, phosphoric acid and nitrogen removed in a ton of air dry matter by some of the principal crops:

	Nitrogen.	Phosphoric Acid.	Potash.
Cotton seed and lint	45.0	18.0	18.9
Corn, grain	33.5	14.0	8.3
Oats, grain and straw	23.3	8.2	19.5
Timothy hay	23.0	6.6	28.0
Sweet potatoes	4.8	2.0	10.0
Irish potatoes	6.7	3.7	12.2
Sorghum	26.6	14.0	26.6

But different plants have different effects on the soil, and the quantity of plant food removed by each is no exact measure of that plant's influence on the soil. As an instance, cotton leaves the soil in a very different condition from oats. Legumes, such as cowpeas and clover, always leave the soil in a better condition than before they grew on it, while cotton leaves it in a worse condition. Cowpeas, when removed for hay, take off a large quantity of nitrogen, but little or none of that nitrogen was taken from the soil, but was taken from the atmosphere by the cowpeas as they grew, a feat that cotton and corn or other crops than legumes do not perform. The nitrogen that is removed in those crops is taken from the soil, and diminishes the soil's supply to that extent, whereas the legumes do not diminish the soil nitrogen, but add to it from their roots and from the litter and from the tops.

Lime and Lime Compounds in the Improvement of Worn Cotton Soils.—Lime, gypsum and marls have been used in several experiments for the purpose of ascertaining their value as aids to improve the worn Station soil, but not one of these experiments showed a profit or any benefit whatever to the crops. The marl experiments were made at the request of farmers and others who were hopeful of some benefit from the use of native marls, and who supplied them to the Station for the experiments. Lime is not properly a fertilizer in the sense of being a plant food that worn soils are deficient in. Its benefits in agriculture are due to the physical effects that it exerts on the soil, and also to the chemical action produced on other compounds of plant food in the soil. As to marls that contain no potash or phosphoric acid, similar or less beneficial results would be expected than was produced by lime or gypsum. But if any marls can be found that contain any of those elements they might, on that account, be profitable on the sandy pine soils of South Arkansas, that being the soil that is most deficient in those elements. The cost of transportation is the controlling item in the use of marls on soils where they are beneficial.

GENERAL REMARKS.

The methods of soil improvement that the various experiments subsequently detailed indicate to be profitable and proper, are substantiated in practice by many farmers in this State, and especially by farmers in sections of other Southern States where the soil years ago reached the state of unprofitable production without the aid of fertilizers. The potato and strawberry growers of this State find cotton meal and crushed or fermented cotton seed to be more profitable for those crops than any commercial fertilizer. But while the experiments of the Station and the practice of farmers indicate the proper methods for improving worn soil, there exist many modifying conditions which make it imperative on the farmer to conduct experiments on small plots and to keep accurate records of them and also to keep records of his general crops in order that he may understand his own individual environments in the improvement of his soil, and of its profitable maintenance. Arkansas soil has not yet been brought to the point of exhaustion by cotton culture that the soil has been brought to in some of the other Southern States, and therefore the Arkansas farmer has not yet begun the purchase and use of commercial fertilizers on his cotton and corn crops as the farmer in other States has been doing for many years. If the Arkansas farmer will begin now before his soil is exhausted, and pursue such methods of soil improvement and animal production in connection with his cotton growing as is indicated by the results of the experiments made along these lines, he can avoid the extensive use of commercial fertilizers on that crop and on his other staple crops.

Animal Production in Connection with the Improvement of Worn Cotton Soils.—The price of cotton and worn soils are conditions that have arisen in the cotton grower's business which now require of him the rotation of crops and the growing of animals in connection with cotton growing in order that cotton may be produced at a reasonable profit. By properly manipulating animal production a profit is secured from it in addition to the increased profit from the cotton crop. I have endeavored by some experiments to ascertain some useful information on this subject of profitable animal production in connection with cotton growing. The results of that effort are two published Bulletins, Nos. 31 and 41. The former relates in detail to the experiments of fattening mature steers on cotton seed and cowpea hay. In the experiments of soil improvement in this Bulletin, cowpeas and cotton seed or cotton seed meal are shown to be the best manures for crops on worn soils, and they are also known as being most excellent cattle foods. Consequently their utilization in a proper and economical manner as foods for cattle before being utilized as manures produces in that way another important profit, and without any practical loss to those foods as soil improvers. All of this and related matter is reported in Bulletin 31. Bulletin 41 relates in detail to pork production on crops gathered by hogs and a succession of crops for hogs. The relation of this experiment of pork production to the improvement of worn soils exists in the profitable utilization for pork production of leguminous crops grown in a system of crop rotation to improve worn soils. A large profit is thus produced in the pork without any diminution of the benefit to be derived from the rotation. And as to the value of rotation, the rotation experiments reported in this Bulletin indicate its benefit and necessity on worn cotton soil. Other animal products besides that of beef and pork can be more profitably produced in connection with the improvement of worn soils than can be secured when done separately. They are milk and butter, mutton and wool. But I have not yet conducted any experiments with those products. The low price of cotton and the constantly decreasing soil fertility will eventually drive the cotton farmer to the combined practice of soil improvement and animal production, and then he will realize profits greater than he ever did realize when cotton sold for much more than its present price and when his land was more fertile than it is now.

EXPERIMENTS AT NORTHEAST SUB-STATION AT NEWPORT.

BY G. B. IRBY.

The soil of that Station is a worn sandy loam and has been cultivated for over twenty-five years in cotton and corn, but mainly in cotton. It lies well; there is scarcely a foot elevation in the field. It is what is called second bottom land, and yields now, in good seasons, without manures, about 25 bushels of corn and 500 to 600 pounds seed cotton per acre. This Station has been the main place where these cotton soil improvement and feeding experiments have been made. Many cotton and corn experiments have been made in the last five years that are not reported in this Bulletin for the reason that their character and results are in accord with those made in 1896.

The various points of information to be sought in these experiments have been stated, but a brief repetition of them here will be convenient to the reader in studying the experiments.

The value of nitrogen to crops on worn cotton soil.

The value of cotton seed and cotton meal nitrogen as compared with chemical nitrogen to crops on worn cotton soil.

The sufficiency of nitrogen in one crop of cowpeas and cowpea stubble for a succeeding crop of corn and cotton.

The value of potash and phosphoric acid to cotton, corn and other crops on worn cotton soil.

The value of vegetable matter to crops on worn cotton soil.

The beneficial influence of one crop of cowpea vines and cowpea stubble in a rotation on succeeding crops of different kinds.

The weather conditions were extremely unfavorable to fertilized cotton in 1896, being *excessively hot* and dry. See weather table on last page.

THE VALUE OF COMMERCIAL FERTILIZERS, COTTON MEAL AND BARNYARD MANURE FOR COTTON ON SOIL AFTER TWO CROPS OF COTTON.

This soil in 1894 grew cotton with fifteen two-horse wagon loads of barnyard manure per acre. In 1895 it grew cotton without manure.

In 1896 it grew cotton with the following fertilizers:

Plots.	Yield Seed Cotton per Acre.
No fertilizer	932 pounds.
Nitrate soda, 200 lbs., 16 per cent nitrogen	1145 pounds.
Muriate potash, 300 lbs., 49 per cent potash	950 pounds.
Acid phosphate, 300 lbs., 14 per cent phosphoric acid	960 pounds.
Gypsum, 500 lbs	852 pounds.
Cotton meal, 400 lbs., 6 per cent nitrogen	1080 pounds.
Kainit, 400 lbs., 13 per cent potash	840 pounds.
Barnyard manure, good quality, ten two-horse loads	1122 pounds.

The yield of nitrate of soda plot, cotton meal plot, and stable manure plot, produced a good increase, showing in each case the value of nitrogen. The soda nitrogen plot had much more nitrogen than the cotton meal plot.

Potash, phosphoric acid and gypsum were of no advantage to cotton. The difference in color and growth of cotton was much greater on the nitrogen plots, and that caused them to suffer more from heat and drouth than the other plots.

THE VALUE OF COMMERCIAL FERTILIZERS, COTTON MEAL AND BARNYARD MANURE FOR COTTON ON SOIL AFTER TWO CROPS OF TURNED-UNDER COWPEAS.

This soil adjoins the above and grew sorghum in 1893 and a crop of cowpeas in 1894, and one in 1895. Each crop was turned in soil in the fall of the year in which it grew.

Plots.	Yield Seed Cotton per Acre.
No manure	1304 pounds.
Nitrate soda 200 lbs., 16 per cent nitrogen	1265 pounds.
Muriate potash, 300 lbs., 49 per cent potash	1329 pounds.
Acid phosphate, 300 lbs., 14 per cent phosphoric acid	1381 pounds.
Gypsum, 500 lbs	1315 pounds.
Cotton seed meal, 400 lbs.. 6 per cent nitrogen	1213 pounds
Kainit, 400 lbs., 13 per cent potash	1134 pounds.
Barnyard manure, ten loads, good quality	1207 pounds.

This soil was full of cowpea vegetable matter and was in an excellent condition for the chemical manures to act; but if these fertilizers exerted any influence, it was too small to be of any consequence.

The nitrogen plots in this experiment had more foliage, were larger, and consequently suffered more from the heat and drouth than the other plots did, just as similar plots suffered in the above experiment. It is clear that the pea vines supplied all the nitrogen needed by the cotton. Comparing the yields of this experiment with the one above shows the value of pea vines. The soil of the above experiment was treated to manure in 1894, whereas the pea vine soil was exhausted by sorghum in 1893. That the drouth affected the more vigorous growing nitrogen plots in both experiments, and that the whole pea land experiment was larger and later, is shown by the first picking. August 15, 50 per cent more cotton was open on the cotton land experiment than on the pea land experiment. The heat was terrible from August 1 to August 15, ranging from 101 to 106 in the shade. The cotton on the two potash plots in both experiments was off color throughout the season, but showed it less at the latter part of the season.

The cotton meal and stable manure plots in both experiments were larger and richer than any of the other plots.

THE VALUE OF COMMERCIAL FERTILIZERS, COTTON MEAL AND STABLE MANURE FOR CORN ON WORN COTTON SOIL AFTER COTTON.

This soil grew peas in 1894, cotton in 1895, and fertilizer corn experiments in 1896. The cotton stalks were cut and turned in the fall of 1895.

Plots.	Yield Bushels Corn per Acre.
No fertilizer	20
Barnyard manure, good quality, ten two-horse loads	26
Gypsum, 500 pounds	14
Muriate potash, 300 pounds, 49 per cent potash	13
Nitrate soda, 200 pounds, 16 per cent nitrogen	32
Kainit, 400 pounds, 13 per cent potash	15
Acid phosphate, 300 pounds, 14 per cent phosphoric acid	19
Cotton meal, 400 pounds, 6 per cent nitrogen	29
No fertilizer	21

The nitrogen plots surpassed the others in yield, thus again showing the soil's need of that plant food. The soda nitrogen plot exceeded the cotton meal nitrogen plot only 3 bushels, but the soda nitrogen plot had much more nitrogen than the cotton meal plot. In these three experiments the soda nitrogen cost $4.50, while that of cotton meal nitrogen cost $3.80.

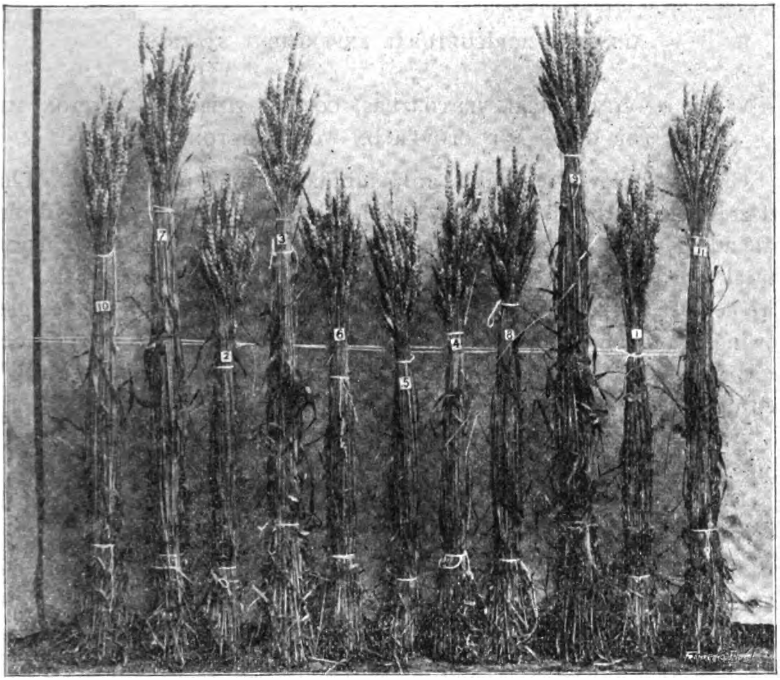
The potash and phosphate plots showed no benefit. The potash plot was a little off color during the growing season. The nitrogen plots had a better color and growth and matured earlier than other plots. These differences were very distinct. But none of the fertilizers, however, were profitable. The heat and lack of needful rain at tasseling stage no doubt diminished the yields of the advanced nitrogen plots. When the other plots reached that stage they escaped serious injury by the fall of rain. The lack of vegetable matter in the soil was clearly shown by this corn during the dry spell. Corn on adjoining plots with cowpeas turned in soil withstood the effects of drouth far better than the fertilized experiments which had no vegetable matter.

POTASH, PHOSPHORIC ACID AND LIME APPLIED DIRECT TO CORN AND COTTON ON TURNED PEA VINES AND THE SAME APPLIED FIRST TO THE PEAS TO BE USED BY THEM BEFORE TURNING UNDER FOR CORN AND COTTON.

This is a practice often recommended, but on this soil there was no advantage gained to the corn or cotton by allowing peas to first have the use of the potash and phosphoric acid. The peas grew no better where those fertilizers were applied than where not applied. Showing that there is enough potash and phosphoric acid in this soil for cowpeas. They were applied at the following rates: Lime, 500 pounds; kainit, 250 pounds; acid phosphate, 250 pounds. In connection with other experiments this is conclusive, but in the worn sandy pine soils of South Arkansas there is not so much potash and phosphoric acid, so that an application of those foods would no doubt be beneficial to the peas, and therefore on that soil the above practice would be advantageous. See fertilizing experiments on that soil in experiments at Southern Sub-station, page 97.

THE VALUE OF COMMERCIAL FERTILIZERS AND NITROGENOUS MATTER AND COWPEAS FOR WHEAT ON WORN COTTON SOIL.

This experiment is detailed at length in Bulletin 29. The need of vegetable matter and nitrogen by this soil is fully shown in this experiment. Cotton seed applied to wheat the previous year produced no effect on wheat the succeeding year. See Bulletin 29 for details.



MANURE EXPERIMENTS WITH WHEAT ON SANDY SOILS.

The number of each sample in the cut is the number of the plot upon which the sample grew.

TABLE OF YIELDS, 1893-94.

Plot No.	Method of Treatment.	Yield of Bushels Per Acre.
	WHEAT GREW ON PLOTS 1 TO 7, 1892-93.	
1	Wheat, following wheat to ascertain the residual effect of 40 bushels cotton seed applied per acre, 1892-93.........	5 bu. 46 lbs.
2	Nothing	5 bu.
3	10 wagon loads horse manure per acre..	15 bu. 16½ lbs.
4	150 pounds acid phosphate	6 bu. 28½ lbs.
5	150 pounds kainit	6 bu. 9⅓ lbs.
6	200 pounds gypsum..	7 bu. 53 lbs
7	Peas planted July 31, turned under green October 10......	16 bu. 53 lbs.
	WHEAT ON PLOTS 8 TO 11, 1891-92, COWPEAS SPRING 1893.	
8	Pea roots	10 bu. 28 lbs.
9	Pea vines with pods on vines	18 bu. 10½ lbs.
10	Pea vines with pods off vines.................................	15 bu. 30½ lbs.
11	Green pea vines with pods on vines—turned under green July 31...	14 bu. 32 lbs.

THE VALUE OF COMMERCIAL FERTILIZERS, COWPEA VINES AND COTTON MEAL FOR GRASS AND CLOVER ON WORN COTTON SOIL.

Grass and clover refused to grow profitably on the natural soil. Those that grew the best were only 3 or 4 inches high. Where kainit, acid phosphate and gypsum were applied the grasses and clover did no better than on natural soil, but when sown on turned cowpea vines they grew well. The more cowpea vines turned in the soil the better the grass and clover grew, showing again as with the wheat and other crops in the above experiments the soil's need of vegetable matter and nitrogen, but more especially the need of vegetable matter for grasses and grains.

Experiments made with rye and reported in Bulletin 18 also show the value of nitrogenous vegetable matter.

Experiments made with oats show exactly similar results, but they have not been published.

Irish Potatoes—Have been tested on worn cotton soil with and without commercial fertilizers, cotton meal and cowpea vines. The results show cotton meal to be beneficial, and also the pea vines, but potash and phosphoric acid were of little value, and this was a little surprising. But in the section of the State where potatoes are grown by the train load for Northern markets the growers say that cotton meal is the cheapest and far the best fertilizer for their early potatoes.

The large strawberry growers report similar experience. Potato and strawberry growers use cotton meal exclusive on potatoes and strawberries. No chemical fertilizers of any kind are used. The experienced practice of those growers confirms the value of cotton meal for fertilizing as compared with chemical nitrogen.

ROTATION EXPERIMENTS.

The reader is invited to observe in these experiments the beneficial effects of pea vines and pea stubble on succeeding crops and also the small difference between the value of vines and stubble together and the stubble alone. Showing that the vines as far as their benefit over the stubble on the first succeeding crop is concerned are worth more than that for hay, hence it is always advisable to cut the first crop for hay and turn under the second crop. It is also advisable to cut all the vines for hay if the hay is to be economically fed and the manure wisely saved and returned to the soil.

ROTATION EXPERIMENTS IN THE IMPROVEMENT OF WORN COTTON SOIL AT THE NORTHEAST SUB-STATION.

No attempt was made in these experiments to determine a system of crop rotation, or the crops that should succeed each other in a rotation, because that is a problem for every farmer. It can only be determined by each farmer for himself in his individual preference and surroundings, which of course differ from those of all other farmers. The real object of these experiments was to determine the value of cowpeas to succeeding crops, but mainly to cotton and corn. And the difference in value of a whole crop of cowpea vines, pods and stubble to a succeeding crop of cotton and corn and the value of cowpea stubble alone; the value of vines with and without the pods; whether clover is equal to cowpeas for improving worn cotton soil.

The result of this last question may be stated now without looking at the detailed experiments. The cowpea is superior to the clover as an improver of worn cotton soil. In fact, the clover, whether red or crimson, is of no value as compared with cowpeas. Clover will not grow on worn cotton soils while cowpeas will flourish on such a soil unless it be absolutely barren. Clover is very uncertain, difficult to get a stand, while neither objection applies to cowpeas. The only soil on which clover claims any consideration with cowpeas, and is superior, is in a rotation on *fertile soil.* The numerous ways in which cowpeas can be advantageously used with other crops and between other crops in the same growing season make them the most valuable plant of all plants for Southern agriculture. Whether they are grown for feeding or fertilizing on worn soil their value holds equally good in either case.

It is not my intention here to discuss in detail the reasons why every farmer should rotate his crops. Those reasons every farmer should know, but whether they do or do not know them, it is a fact that but few practice rotation in this State. One of the most important benefits of cowpea rotation to cotton, corn, wheat and other staple crops is to diminish the injury from drouth. The vegetable matter greatly improves the water holding power of the soil, and it also holds the nitrogen in the soil as well as adding it to the soil.

THE EFFECT OF COWPEAS, PEA STUBBLE AND COTTON ON A SUCCEEDING CROP OF COTTON.

The peas were picked from the vines on one plot while the vines were cut off the other plot for hay, then the vines and stubble on both plots were turned in soil and cotton planted following spring.

Yield seed cotton on pea vine plot	1,409 pounds per acre.
Yield seed cotton on pea stubble plot	1,291 pounds per acre.
Yield seed cotton on cotton land plot	1,008 pounds per acre.

Similar comparative yields as the above have been observed with cotton every year for five years.

THE EFFECT OF COTTON AND CORN WITH PEAS IN CORN (PODS PICKED OFF YIELDING 385 POUNDS IN HULL) ON SUCCEEDING CROP OF COTTON.

Yield seed cotton on land three years in cotton	650 pounds seed cotton.
Yield seed cotton on corn and pea vine land	1,106¼ pounds seed cotton.

THE YIELD OF CORN ON LAND ROTATED WITH DIFFERENT CROPS AS COMPARED WITH CORN ON LAND THAT HAD GROWN COTTON EXCLUSIVELY FOR FOUR YEARS.

Yield corn on four year cotton land	16 bushels per acre.
Yield corn on pea vines turned under	39.7 bushels per acre.
Yield corn on pea stubble turned under	33.6 bushels per acre.
Yield corn on one year cotton land	25.8 bushels per acre.

Note effects of four years of cotton as compared with effects of one year of cotton, and note the different effects of cowpeas and cotton on corn following them.

THE EFFECTS OF PEANUTS, COTTON AND SORGHUM ON CORN FOLLOWING THEM.

Peanut plots	39 bushels corn per acre.
Sorghum plots	23.4 bushels corn per acre.
Cotton plots	28.6 bushels corn per acre.

Sorghum was more harmful on the succeeding corn crop than cotton was harmful.

THE EFFECT OF DIFFERENT PRECEDING CROPS ON YIELD OF CORN—HOG EXPERIMENT, 1895, BULLETIN 41.

Yield corn on pea stubble after oats	37.4 bushels per acre.
Yield corn on peanut land, peanuts were gathered by hogs, 1895	36.8 bushels per acre.
Yield corn on sorghum land	22.6 bushels per acre.
Yield corn on sweet potato land	20.7 bushels per acre.

Sweet potatoes and sorghum are exhaustive of nitrogenous matter, and that fact is shown in the yield of corn. Whereas pea stubble and peanut land added nitrogen to the soil. These crops were those used in the rotation hog experiment.

EFFECT OF DIFFERENT PRECEDING CROPS ON YIELD OF CORN.

Yield corn on corn land	24.2 per acre.
Yield corn on pea stubble after oats	37.2 per acre.
Yield corn on corn (and peas in corn) land	34.6 per acre.
Yield corn on cotton land	33 per acre

EFFECT OF DIFFERENT CROPS ON A SUCCEEDING CROP OF WHEAT.

The reader is referred for this experiment to a preceding page. This experiment is the most emphatic in showing the beneficial effects of cowpeas, because, as is well known, wheat absolutely refuses to grow on worn cotton soil.

THE EFFECF OF PEAS GROWN FOR HAY AND CORN GROWN FOR SILAGE ON A SUCCEEDING WHEAT CROP.

Yield of wheat on cowpea land, per acre	1,600 pounds grain and straw.
Yield of wheat on silage land, per acre	860 pounds grain and straw.
Height of wheat on cowpea land	30 inches.
Height of wheat on silage land	18 inches.

EFFECT OF COTTON AND PEAVINES ON A SUCCEEDING CROP OF RYE AND BARLEY FOR WINTER SOILING.

Yield barley hay on cotton land	1,600 pounds dry.
Yield barley hay on pea vine land	2,700 pounds dry
Yield rye hay on cotton land	1,440 pounds dry.
Yield rye hay on pea vine land	2,700 pounds dry.
Height of barley, March 15, on cotton land	15 inches.
Height of barley, March 15, on pea vine land	24 inches.
Height of rye, March 15, on cotton land	8 inches.
Height of rye, March 15, on pea vine land	24 inches.

This is from Bulletin 18.

We have made other rotation experiments with other grains and grasses, but they will not be published here as their results accord fully with those above.

SOME FERTILIZER EXPERIMENTS ON SOUTHERN SUBSTATION AT CAMDEN.

BY C. L. NEWMAN.

The soil used in these experiments is badly worn and washed light upland sandy soil. Its chief forest growth was pine. Experiments here and at North Louisiana Station, at Calhoun, indicate a benefit from use of some potash and phosphoric acid, the soil of South Arkansas and North Louisiana being similar in general character.

In the experiments, the cost of the fertilizers and of applying them must be considered before deciding upon the profit of the increased production. The acid phosphate, kainit and nitrate soda in the trials contained respectively 14, 13 and 16 per cent available plant food.

COTTON FERTILIZER TEST.

This fertilizer test indicates that the Station upland soil needs all three, phosphoric acid, nitrogen and potash. It will be noticed that the plot containing these three ingredients combined gave a yield of more than double the average of the two no manure plots.

For weather table see Bulletin 34.

	Yield of seed cotton per acre.
No manure	560
400 pounds acid phosphate	880
200 pounds nitrate soda	874
400 pounds kainit	918
400 pounds acid phosphate 200 pounds nitrate soda	1,120
400 pounds acid phosphate 400 pounds kainit	982
200 pounds nitrate soda 400 pounds kainit	930
400 pounds acid phosphate 200 pounds nitrate soda 400 pounds kainit	1,184
1,000 pounds cotton seed meal	1,020
No manure	620

FERTILIZER TEST WITH WHIPPOORWILL PEAS.

The soil selected for the experiment was poor sandy upland and grew oats in 1893. After the oats were harvested the plot was not again planted until April 7, 1894, when the peas were put down. The plot was, however, cultivated in 1893 (after the oats were taken off) for the purpose of freeing it of Bermuda grass. The rows were marked off 30 inches apart, the fertilizer distributed and covered, and the peas planted thick in the drill.

Fertilizers.	Peas in hull, dry weight pounds.	Green weight of vines, pounds.
No manure	37	7,848
200 pounds nitrate soda	19	8,123
200 pounds kainit	112	10,416
200 pounds acid phosphate	510	13 947
200 pounds nitrate soda 200 pounds kainit 200 pounds acid phosphate	1,091	18,310
350 pounds cotton seed meal	485	15,042

Nitrate of soda alone gave practically no increase. This, very probably, is due to its having leached during the early stage of growth, for until about the time the first blossoms appeared the nitrate of soda plot was growing more vigorously than any other plot, excepting the plot containing the three fertilizers combined, and had apparently twice the weight of vines as were growing on the kainit plot. After the middle of June, neither the nitrate of soda or the no manure plots made perceptible increase in growth notwithstanding over 6 inches of rain in July, while the kainit plot made at least a third of its growth after July 1. When the vines were cut in September the acid phosphate plot had very probably lost numerically more leaves than all the others combined, while the nitrate of soda, kainit and no manure plots had lost practically none. It is evident that something was needed by the soil to hold the nitrates.

FERTILIZER EXPERIMENTS WITH SPANISH PEANUTS.

Early in April Spanish peanuts were planted in 2-foot rows, two seed being dropped every foot in the rows. The fertilizer had previously been distributed, bedded on and the rows marked off. The plots were marked off 2 by 1 foot with lines, making the hills in exact checks. The stand was perfect, except in the cotton seed meal plot, which grew 86 per cent of a stand. The cotton meal perhaps caused this. The yield of this plot was farther decreased by about 16 per cent rotting in the ground before gathered. On the plot with the three fertilizers combined 9 per cent rotted, and 4 per cent rotted on the nitrate of soda and 9 per cent on the stable manure plot. The acid phosphate and kainit plots were practically all sound. This rotting was apparently due to some fungous disease. When a plant was affected nearly every peanut on it was either rotted or rotting when dug. The vines above ground gave very slight, if any, indication of their diseased condition below. In two instances, where two plants occupied one hill, the peanuts of one plant were all rotten, while those of the other were sound except where the pods were in contact, or nearly so, with the rotted ones of the other vine. The leaves of the nitrate of soda and cotton seed meal plots were also attacked by one, and very probably, two, species of fungi, while the other plots were very perceptibly freer from it.

The following gives the dry weight of the peanuts gathered from the different fertilizer plots:

Fertilizer.	Bushels per acre.
200 pounds nitrate of soda	105
200 pounds kainit	127
200 pounds acid phosphate	117
200 pounds nitrate of soda 200 pounds kainit 200 pounds acid phosphate	113
350 pounds cotton seed meal	119
Handful of stable manure to the hill	118
No manure	94

The yields do not include the rotten peanuts.

The standard weight of a bushel of Spanish peanuts is 30 pounds.

THE VALUE OF SOIL ANALYSIS OR SOIL TESTS WITH FERTILIZERS.

The usual advice given to farmers for determining the kind of plant food needed by their worn soils is a soil analysis or soil test with the several necessary elements of plant food, singly and in combination, in small plots of equal area and equal in all other respects, the elements used for trial being those usually absent in worn soils, and that are supplied in commercial fertilizers, potash, phosphoric acid and nitrogen. The truthfulness of such a test is so dependent upon several conditions which are wholly beyond practical control that the results are very inconclusive, more especially with reference to the nitrogen. The results for it are so influenced by the preceding crop and its treatment that nothing reliable can be secured from a test of it on a soil unless the influence of the preceding crops is known, whether the preceding crop was leguminous, or whether it was a grain crop, etc., and also the nature and extent of previous manures applied to the soil. But with reference to nitrogen, it may be said as a *general rule* that it is needed by all worn soils in the South. It then becomes a question of what is the cheapest and most enduring form in which the nitrogen should be applied to the soil.

As to the truthfulness of soil tests with potash and phosphoric acid, the results are so dependent upon and influenced by the soil, water, rainfall and tillage that single experiments are but limitedly reliable.

The need of all worn cotton soils is not the same for these two elements of plant food as it is for nitrogen. Consequently there is no general rule to go by with reference to their use. The truck farmer can, perhaps, with safety and profit use both on his high priced truck crops; but the cotton and corn, or staple crop farmer, whose products are less valuable per acre, must know whether it is profitable to use one or both of these on his worn soils. In order to secure reliable and conclusive results in soil tests with potash and phosphoric acid, the test must be carried on for a number of years, and under all possible conditions, especially as to previous crops, tillage and manuring, and also the tillage given the experiments.

WEATHER RECORD FOR 1896 AT NORTHEAST SUB-STATION.

APRIL.				MAY.				JUNE.				JULY.				AUGUST.			
Date.	Maximum Temp.	Minimum Temp.	Rainfall in Inches.	Date.	Maximum Temp.	Minimum Temp.	Rainfall in Inches.	Date.	Maximum Temp.	Minimum Temp.	Rainfall in Inches.	Date.	Maximum Temp.	Minimum Temp.	Rainfall in Inches.	Date.	Maximum Temp.	Minimum Temp.	Rainfall in Inches.
1	69	39	.52	1	85	60	.03	1	83	70	Tce	1	92	62	.....	1	106	77	.....
2	56	34	*	2	76	53	.05	2	80	65	1.25	2	97	63	....	2	98½	72	.....
3	62	33	†	3	80	52	....	3	89	67	.....	3	100	69	.....	3	103½	69	.....
4	72	44	.....	4	86	57	.....	4	88	67	.....	4	94	75	.....	4	101	72	.....
5	76	41	.....	5	87	57	....	5	90	69	1.20	5	89	71	Tce	5	104	72	.....
6	68	56	....	6	90	58	....	6	90	70	....	6	91	68	.....	6	105	70	....
7	75	43	.....	7	91	58	......	7	89	71	Tce	7	89	63	.....	7	106	72	.....
8	79	53	.11	8	93	58	. ..	8	92	73	.. ..	8	84	59	.....	8	105½	71	.....
9	79	60	.20	9	91	62	Tce	9	82	68	.14	9	88	54	.....	9	103	73	.....
10	85	58	.....	10	90	61	.....	10	70	59	.....	10	94	56	.....	10	102	69	.12
11	85	62	.....	11	87	62	.....	11	78	57	.....	11	91	66	.64	11	101	68	.....
12	78	64	.16	12	87	62	Tce	12	78	64	.....	12	91	70	.04	12	101	69	.....
13	66	56	1.80	13	80	60	.73	13	85	50	.....	13	95	70	.09	13	101	62	.....
14	78	55	.....	14	81	58	.....	14	88	54	.....	14	96	72	.....	14	105	70	.....
15	79	62	.....	15	85	54	.....	15	91	60	.....	15	97	73	......	15	104	67	.....
16	84	68	......	16	85	66	.79	16	85	68	....	16	90	73	.06	16	94	70	....
17	84	60	....	17	89	67	.....	17	88	59	....	17	89	67	1.01	17	95	68	.....
18	82	66	.....	18	89	70	.....	18	93	63	.....	18	98	70	......	18	87	64	.....
19	82	65	.13	19	89	72	Tce	19	93½	63	.....	19	97	74	.....	19	81	61	.03
20	85	62	....	20	85	63	2.19	20	95	62	...	20	94	71	.86	20	85	65	.10
21	84	63	.36	21	90	72	.....	21	96	67	.....	21	94	73	......	21	104	70	.....
22	86	62	.02	22	86	70	.05	22	90	68	Tce	22	95	75	.09	22	102	75	.....
23	86	62	.06	23	89	66	.....	23	83	71	.87	23	98	70	.....	23	91	70	.40
24	89	62	....	24	92	69	.....	24	86	70	.05	24	102	80	....	24	85	65	.....
25	82	63	Tce	25	95	73	.....	25	89	67	.....	25	90	71	.....	25	91	56	.....
26	85	55	.61	26	90	72	Tce	26	80	71	.14	26	99½	72	.....	26	91	60	.....
27	87	59	.....	27	90	68	.....	27	96	70	.....	27	100	74	.....	27	91	51	.....
28	82	63	Tce	28	82	68	Tce	28	91	72	.....	28	101	74	.....	28	85	52	....
29	82	64	.12	29	82	55	.....	29	85	70	.....	29	102	72	.....	29	87	49	.....
30	84	52	.....	30	77	62	1.01	30	87	61	....	30	104½	76½	.....	30	92	60	.....
..	....	.....	. ..	31	91	67	.....	...	....	....	....	31	104½	73	....	31	95	52	. .
		Tot.	4.09			Tot.	4.85			Tot.	3.65			Tot.	2.79			Tot.	.65

*Frost. †Frost and ice.

CONCERNING FERTILIZERS AND MANURES.

There are three ways in which manures may increase soil productiveness: Indirectly, (1) by converting plant food already in the soil into such a condition that it may be more readily absorbed by the roots of growing plants. Directly, (2) by improving the physical condition of the soil, and (3) by supplying necessary elements of plant food.

Among the manures which have an important indirect action on the soil, thereby making plant food already present more readily accessible to crops, are lime and gypsum, or land plaster. Gypsum is instrumental chiefly in making potash in the soil more readily accessible to the plant by changes which are too complex to be explained here. Lime, either in the form of quicklime or marl, assists in a similar way in liberating potash but its more marked influence is in hastening the breaking down of humus or decomposing plant matter in the soil. In doing this the nitrogen which the humus contains becomes converted into compounds soluble in water and which may be taken up by the roots of plants. In this State where long continued warm weather and abundant rains produce even a too rapid decomposition of humus the addition of lime for this purpose is unnecessary and unwise.

Barnyard manure and other vegetable matter decomposing in the soil have more or less indirect action as a manure in that they are instrumental in decomposing the insoluble mineral compounds with the result of making potash and phosphoric acid more available. Their action in this way, however, is only secondary and of minor importance.

The leading articles used to improve the physical condition of soils are barnyard manure and other coarse residues of plants (such as straw, cowpeas, clovers and green crops plowed under for manure), lime and ashes. Of these barnyard manure, and other material of its class, improve the water holding power of sandy soils because of their property of holding large quantities of water in themselves in much the same way that a sponge absorbs and holds water. Thoroughly mixed with a *clay* soil they assist in making *it* more porous and open. It thus becomes more permeable to air, less retentive of water and less liable to cake on drying. Vegetable matter has also a warming influence on soils. Because of its dark color it makes them absorb heat more readily and by assisting the escape of water in clay soils reduces the cooling effect of the very large amount of evaporation which otherwise takes place. The purpose of barnyard manure and litter in improving the physical condition of soils will be best served by applying that which is well rotted to sandy soils and that which is more coarse and straw-like to clay soils.

Lime and ashes improve the physical condition of sandy soils by binding the particles together and, especially the ashes, by filling the spaces between the sand grains with its fine particles. They improve the physical condition of clay soils by making them more porous and open. The particles of clay are very minute. So minute that when mixed with water they remain in suspension almost indefinitely. The water of rivers is muddy largely from the presence of these clay particles. Large rivers like the Mississippi remain muddy until they come to salt water. When the muddy water of the river mixes with the salt water of the gulf or ocean many particles of clay unite and form little masses which soon fall to the bottom. A teaspoonful of brine added to a quantity of muddy water soon clears it in the same way. Lime water will produce results similar to that of the salt. As clay ordinarily exists in soils after heavy rains each particle is separate and distinct much like the clay in suspension in muddy water. Lime and ashes in the soil cause the particles to unite in small masses of irregular size and with spaces between them. This enables the excess of water in the soil to drain away and the soil remains loose and mellow, enabling air to enter and plant roots to develop.

Commercial fertilizers, as that term is understood, refers to substances which are used as a manure not for the purpose of altering the physical condition of the soil, nor for the indirect action of liberating plant food already present, but rather for supplying the available plant food which they contain. The elements of plant growth in which soils are most likely to be deficient, and the only ones taken into account in estimating the value of commercial fertilizers, are nitrogen, phosphorus (in phosphoric acid) and potassium (in potash). Any material which does not contain one or more of these three elements in appreciable quantity has no value as a commercial fertilizer. A substance may contain one or more of these elements in considerable quantity and still have little value as a manure because the element is in a compound not suited to the needs of the plant. An example of such an article is leather, which contains a considerable quantity of nitrogen but which decomposes so slowly, even when finely ground, that the nitrogen which it contains is almost of no use to crops.

Any material which does not contain in a proper form one or more of these three elements will not ordinarily be of sufficient value to crops to justify a farmer in using them as a manure at a cost of more than $6 or $7 per ton. Lime, plaster, etc., can generally be had at a less price, and when they cannot their use as a manure is not likely to prove profitable, even though it may when obtained at a less cost.

It is a well recognized fact that agricultural soils differ greatly and the question naturally arises: Are all soils in this State likely to be equally deficient in the three elements named? The answer is positively that they are not. Clay soils are almost invariably well supplied with potash, while gravelly and sandy soils are likely to be deficient in that material. With phosphoric acid also it is the sandy soils that are most likely to be deficient.

The best index as to the nitrogen contents of soils is the amount of humus or decaying vegetable matter which they contain. This is the material which will be burned from a dry soil when it is placed on a hot stove. It is the material which is being continually burned from the soil by natural agencies. The conditions for the working of these agencies are greatly improved in cultivated soils and the result is that such soils soon become deficient in humus, and consequently in nitrogen. It is largely due to this loss of humus that soils which were fairly fertile when first broken from woodland or prairie soon become sterile and barren under careless and unwise management. An examination of such soils will show that the former dark color of the first few inches has disappeared. The original supply of nitrogen has become exhausted. The elements of fertility in which the majority of soils in this State are deficient is nitrogen. The eye readily detects the absence of humus in the cultivated soils of all sections.

To keep the soil well supplied with humus requires constant and systematic effort on the part of the farmer. It may be done by growing clover and cowpeas, by returning to the soil such straw, stable manure and litter as the farm may produce and by making use of these means in connection with a systematic rotation of crops. A discussion of these means does not come within the scope of this Bulletin. They have been discussed in various publications of the Station and probably will be discussed in others which follow.

Different crops have different needs. On the same soil some kinds will be especially benefited by nitrogen, some by phosphoric acid, and some by potash. Cowpeas and clover will receive little or no benefit from nitrogen, but they may on some soils be greatly benefited by phosphoric acid and especially potash. Wheat and oats are believed to be especially benefited by nitrogen, potatoes and tobacco by potash, and turnips by phosphoric acid, especially phosphoric acid soluble in water. Soluble phosphoric acid may also be especially beneficial to wheat by giving it an early and vigorous start.

To determine the special needs of a given crop on any particular soil requires careful soil tests which are often uncertain, misleading, and variable in different years, so that the results of one year may exactly contradict those of the former. For this reason, except in instances where there are clear indications to the contrary, manures are generally applied containing all three of the elements under consideration. Commercial manures will generally yield the best returns when applied to a soil already in a fair state of fertility and their use on soils which are markedly deficient in humus is a very doubtful practice. Neither will they be profitable on a badly cultivated or poorly drained soil.

While barnyard manure differs considerably according to the kind of animals by which it is produced, the food of those animals, and the conditions to which their droppings are subjected, it all contains a very small amount of the leading elements of plant food. The general composition of such manure is expressed in the following table:[*]

Nitrogen varies from	0.40 to 0.75 per cent.
Phosphoric acid varies from	0.20 to 0.40 per cent.
Potash varies from	0.40 to 0.75 per cent.
Water varies from	70.00 to 80.00 per cent.

It thus appears that a ton of such manure will not contain at most more than 15 pounds of nitrogen, 8 pounds of phosphoric acid, and 15 pounds of potash, while the probabilities are that it will contain much less. As a general manure it is relatively deficient in phosphoric acid, the common practice in compounding such manures being to put this ingredient in the proportion of from two to five times the nitrogen and the potash. Again, a considerable proportion of each of the elements which this manure contains does not become immediately available when it is applied to the soil, but only so rapidly as the humus which such manure forms may decompose. This may extend over a period of several years.

The importance of humus or vegetable matter in all soils cannot be too strongly emphasized, and there is often a benefit derived from an application of barnyard manure which would not come from the same quantities of nitrogen, phosphoric acid and potash in mineral manures, unless such application be made to a soil already well supplied with humus.

The opinion has been frequently expressed in one way and another that the droppings of cattle where they are fed in considerable quantities on cotton seed hulls and meal are of great value as fertilizers because of the unusually rich quality of the food which these animals consume. While it is true that such manure is more valuable than the droppings of cattle as ordinarily fed it has no value which justifies the ranking of it as a commercial fertilizer. In such feeding the meal and hulls are mixed in the proportion of about 500 pounds of the former to 2,000 pounds of the latter. This meal will contain about 35 pounds of nitrogen and the hulls about 14 pounds. This is equivalent to about 39 pounds of nitrogen in a ton of the mixture. Before this is removed to the manure heap it is diluted with an equal weight or more of water. To remove the water by drying the material is a slow and difficult process. A large part of the nitrogen which the material contains is in compounds which rapidly decompose and allow the nitrogen to escape into the air. The nitrogen thus set free may be largely retained by ground gypsum (land plaster) so long as the mixture remains wet, but the nitrogen will escape for the most part as the mass becomes dried. The result is that in either a wet or dry condition the material will contain only a small proportion of nitrogen, phosphoric acid and potash. A sample of the thoroughly dry material which was believed to be highly valuable was analyzed recently with the following results:

---

[*] U. S. Department of Agriculture. *Farmers Bulletin No. 21.*

Nitrogen	1.10 per cent, or	22 pounds per ton.
Phosphoric acid	.45 per cent, or	9 pounds per ton.
Potash	.53 per cent, or	11 pounds per ton.

Examinations of the wet material which have been made here show it to contain even less proportions of the more valuable manure elements. So that at no time is this material of sufficient value to justify its being loaded onto cars and shipped for use as a manure and then hauled upon wagons and spread upon the soil. The highest valuation will not make it worth more than $3 or $4 per ton when compared with cotton seed meal and other material which may be used as a manure. However, it may be profitably used by farmers and truck gardeners in the immediate vicinity of where it is produced and where it need not be hauled any considerable distance. It may also be spread upon the soil by the cattle themselves where they can be allowed the range of a large field during the feeding period.

The mixed commercial fertilizers of the markets usually contain nitrogen, phosphoric acid and potash in proportions which suit the fancy of the manufacturer or in proportions which he thinks will suit the fancy of his customers. These goods sometimes have special names such as potato fertilizer, tobacco fertilizer, cotton fertilizer, etc., but there is no reason to believe that they have any specific value for any of these crops or act in any way other than as a general fertilizer. They are often beneficial but there is no reason to believe that they are in general any more so than they would be if they contained the ingredients in various other proportions. The materials which are compounded to make these fertilizers are no different than the farmer can buy in the unmixed condition. Often he can buy them in the unmixed condition and mix them at home for less cost than he can buy the mixed goods.

Home mixing of fertilizers has some prominent advantages to the farmer, among which the following may be mentioned: It enables him to know the exact nature of the material which he uses. He can use the proportion of each ingredient likely to be best suited to his crop and soil. He can mix the material thoroughly and at little cost by hand labor and, by a little care and foresight, at a time when his men could not otherwise be profitably employed. He can apply a part of the material separate from the remainder. It is often best to apply potash salts several weeks before planting, especially where kainit or muriate of potash are used, yet it would not be wise to apply the nitrogen and phosphoric acid at this time. Mixed fertilizers come chiefly from outside the State. Cotton seed meal is produced in large quantities within the State and a large proportion of that produced is shipped away. It furnishes nitrogen in a form from which it is as readily available as in any organic substance and at as low a price. It is not economy to ship cotton seed meal out of the State and then buy it back in mixed fertilizers for this increases the cost of the material without increasing its value.

A study made at the Connecticut State Experiment Station of the comparative cost of nitrogen in commercial manures especially rich in that element shows cotton seed meal to furnish nitrogen at the lowest market value at which the element can be obtained. This occurs, too, after it has been transported hundreds of miles into a land where the freight rates on nitrate of soda (which comes from South America) and on other substances containing nitrogen are quite as low as they are in any section of the country and much lower than they would be into the interior of this State. If the farmers in this State wish to buy nitrogen for their land cotton seed meal will furnish it to them in as cheap a form as it can be had. Cotton seed meal differs somewhat in composition but on the average it contains about 7 per cent of nitrogen (145 pounds per ton), 2.9 per cent of phosphoric acid (59 pounds per ton), and about 1.8 per cent of potash (36 pounds per ton).

Some other substances which are sources of nitrogen for manures are nitrate of soda and sulphate of ammonia, two purely mineral substances of which the first is mined in South America and the other is produced in the manufacture of coal gas. Sulphate of ammonia furnishes nitrogen in its most expensive, but not most valuable, form, and will hardly find its way into the markets of this section. Nitrate of soda contains nitrogen in a very quick acting form. It has been found by experiment that a somewhat larger proportion of the nitrogen which it contains will be utilized by the growing crop than that of any other manure. However, nitrate of soda is very soluble in water, and in this State, where the soil is mostly sandy and where in the spring at the usual time of applying this material there is likely to be a fall of several inches of rain in a few hours there is danger that the substance may be leached from the soil, especially sandy soils, before the plant has had time to make use of it.

Other substances used to supply nitrogen in manures are ground bones and tankage. Tankage is a product of slaughterhouses and is a mixture of flesh, bones, blood, etc. It is likely to vary greatly in composition. The availability of the nitrogen and phosporic acid which it contains as well as that in pure bones depend largely upon the fineness to which they are ground. Unless very finely ground the elements of fertility become available only slowly.

In stating the results of analyses of fertilizers nitrogen is sometimes indicated as pure nitrogen and sometimes as ammonia. Every 17 pounds of ammonia contains 14 pounds of nitrogen.

One of the chief sources of phosphoric acid for manures in this country are the rock phosphates of the southeast United States: Florida, South Carolina, Tennessee, etc. These rocks may be use when simply ground to a fine powder, when the phosphoric acid is present in such condition that it becomes soluble only by use of acids. They may be used also as acid phosphate or superphosphate, in which a greater part of the phosphoric acid has been converted into a condition in which it is soluble in water. This change is brought about by acting on the finely ground bone or on rock phosphate with sulphuric acid. The phosphoric acid soluble in water becomes insoluble in water soon after it is applied to the soil. Before doing so, however, it becomes much more thoroughly distributed in the soil than it could by being applied in the insoluble condition. In all superphosphates a greater or less proportion of the phosphoric acid exists in a condition intermediate between that which is soluble in water and that which is soluble only in acids. When in this condition it is called reverted phosphoric acid or citrate soluble phosphoric acid. This is probably much the same form as the water soluble phosphoric acid assumes soon after it has been added to the soil, and both are more readily available for the use of plants than the form soluble only in acids. For this reason the water soluble phosphoric acid and the reverted phosphoric acid are often grouped together under the name of available phosphoric acid.

Phosphoric acid is sometimes represented by the characters P_2O_5. The insoluble form (that form soluble only in acids) is sometimes designated as bone phosphate, calcium phosphate or phosphate of lime. This is simply another way of stating one fact and may be misleading to purchasers for it requires 2.18 per cent of bone phosphate, calcium phosphate or phosphate of lime to equal 1 per cent of phosphoric acid. Either 2.18 per cent of the one, or 1 per cent of the other indicates 1 pound of phosphoric acid in every 100 pounds of the material.

Other sources of phosphoric acid are bone ash, bone black, ground bones, tankage, cotton seed hull ashes, etc.

The source of commercial potash for all America is the potash salts of Stassfurt, Germany, and many hundreds of tons of these salts are used annually. Potash comes to this country largely in the forms of sulphate of potash, muriate or chloride of potash and in kainit. The sulphate of potash is the most costly of these forms and is believed to be preferable to the others, especially upon tobacco and potatoes, upon which the chlorine which the other forms contain has an injurious influence. This injurious effect of kainit and the chloride of potash may, however, be avoided by applying the material to the soil six or eight weeks before the time of planting the crop and before the ground has been plowed for it. Potash applied to the soil in a soluble condition soon becomes converted into an insoluble form, and there is little danger of its being leached from the soil by rains. On the other hand the chlorine will be largely leached out of the soil in the form of chloride of lime or chloride of magnesia.

Ashes, especially cotton seed hull ashes, are valuable sources of potash in this State. A good quality of cotton seed hull ashes will contain about 25 per cent of potash soluble in water, and about 10 per cent of total phosphoric acid. An average quality of wood ashes will contain about 5½ or 6 per cent of potash soluble in water, and a little less than 2 per cent of total phosphoric acid.

In stating the analyses of fertilizers potash is sometimes indicated as sulphate of potash which may be indicated by the characters K_2SO_4; as muriate or chloride of potash which may be indicated by the characters KCl; or as potash, sometimes actual potash, which may be indicated by the characters K_2O. These different forms of stating the same fact may be compared by the following:

One per cent of potash is equivalent to 1.85 per cent of sulphate of potash.

One per cent of potash is equivalent to 1.53 per cent of chloride of potash.

The amounts of nitrogen, phosphoric acid or potash in the various substances mentioned above are variable. Phosphates, potash salts, tankage and ground bone should be bought only of reliable dealers who will furnish with them a guaranteed analysis showing the amount of nitrogen, phosphoric acid or potash which the goods contain. The analyses of superphosphates should show the amount of phosphoric acid soluble in water, the amount of reverted phosphoric acid and the total amount of phosphoric acid.

The prices per pound of nitrogen, phosphoric acid and potash in the markets are estimated by the cost of various articles of merchandise which are extensively used as manures and which contain considerable quantities of one or more of these elements. For example the cost of potash per pound is estimated from the cost per ton of kainit, of muriate of potash or of sulphate of potash. The number of pounds in a ton of the article having been found by chemical analysis, the cost per pound of the potash can readily be determined, it being considered that the other ingredients have no value. In like manner with phosphoric acid the cost per ton of ground South Carolina or Florida rock or of bone ash having been ascertained the amount of phosphoric acid present is determined by analysis and the cost of the phosphoric acid is computed. Also the cost per pound of soluble phosphoric acid is computed from the market value of superphosphates. The costs of special forms of nitrogen are determined by similar computations based upon the market price of nitrate of soda, sulphate of ammonia, etc. Where any two or all three of these ingredients occur in the same article, the one being considerably in excess of the others, the price per pound of the one which occurs in greatest quantity may be computed by valuing the others at their cost in the leading articles in which they are sold alone, deducting this value from the cost of the article and from what remains of the cost price computing the price of the ingredient as if it were the only one of the three present. In this way the price of cotton seed meal may be considered as practically fixing the price of nitrogen for this section of country.

The price of fertilizer material varies from time to time and in different places according to freight rates and other local conditions. The comparative cost of nitrogen, phosphoric acid and potash in different articles may be seen from the following schedule of prices adopted for 1897 by the Experiment Stations of the New England States.

TRADE VALUES OF FERTILIZING INGREDIENTS IN RAW MATERIALS AND CHEMICALS.

	1897. Cents per pound.
Nitrogen in ammonia salts	13.5
Nitrogen in nitrates	14.
Organic nitrogen in dry and fine ground fish, meat, blood, and in high-grade mixed fertilizers	14.
Organic nitrogen in cotton seed meal, linseed meal and in castor pomace	12.
Organic nitrogen in fine ground bone and tankage	13.5
Organic nitrogen in medium ground bone and tankage	11.
Organic nitrogen in coarse bone and tankage	8.
Phosphoric acid soluble in water	5.5
Phosphoric acid soluble in ammonium citrate	5.
Phosphoric acid in fine bone and tankage	5.
Phosphoric acid in medium bone and tankage	4.
Phosphoric acid in coarse bone and tankage	2.5
Phosphoric acid in fine ground fish, cotton seed meal, linseed meal, castor pomace and wood ashes	5.
Phosphoric acid insoluble (in am. cit.) in mixed fertilizers	2.
Potash as sulphate, free from chlorides	5.
Potash as muriate	4.5

AFTER-EFFECT OF MANURES.*

To look only at the immediate effect of a fertilizer on the growth of a crop seems a short-sighted and improvident policy. A consideration of the relative exhaustion of the soil under different methods of treatment seems nearly or quite as important. In studying this question the experiments of Sir J. B. Lawes and Dr. Gilbert at Rothamstead, England, are of special importance because of having extended over such a large number of years, and because their plan seems especially adapted to answer certain questions which arise in this connection. The principles here involved are apparently of more general applicability than are any which can be deduced concerning the immediate effect of manure, because whatever the initial condition of the soil, the principles of exhaustion apparently are acting in the same general direction. They will, probably, under similar methods of treatment, lead to similar results. Exhaustion then under the same exhaustive methods of treatment becomes for different soils mainly a matter of time. It may be brought about in less than five years, or it may not be brought about in more than fifty.

---

* This article was prepared in 1892 and reserved for publication at a future time. For that reason the results of more recent harvests have not been included in the data given. The points at issue would not be changed by including them. The results of similar experiments on wheat and barley carried on at Woburn, England, for twenty years, on an entirely different soil, support certain points brought out in the article in a very marked degree. (See *Journal Royal Agricultural Society of England*, Vol. VIII., Pt. II., June, 1897.)

The three lines of Rothamstead experiments which seem to give the most serviceable and clearly defined data for our present purpose are, barley continuously grown on plots similarly manured for thirty-eight years; wheat grown in similar manner for thirty-eight years or longer; and permanent meadow land.

The manures in which nitrogen is usually applied to soils contain it in the form of nitrates, ammonia salts, or as parts of organic compounds, either animal or vegetable. Nitrates are readily soluble in water and may be wholly or in part removed in drainage. Ammonia salts and some forms of organic matters are in the soil converted into nitrates probably in the course of a few days at most. A portion of the nitrogen of farmyard manure and of the coarser parts of plants, such as straw, though also for the most part converted into nitrates becomes so changed only very slowly. It is mainly from nitrates that most farm crops obtain their nitrogen supply.

Phosphoric acid is applied to soils either in a soluble or an insoluble condition. If in a soluble condition it is in most soils soon converted into the insoluble form. Potash, except in organic compounds, is nearly always applied in a readily soluble form. It, like phosphoric acid, is soon fixed in the soil and largely preserved from drainage waters.

An illustration of the practical importance of points in the above paragraphs appears from results of the harvest of wheat from certain plots of the experiment at Rothamstead. Two of these plots have been treated on one of each two years with ammonia salts (equal parts sulphate and chloride) at the rate of 400 pounds per acre; on the other, with a mixture of minerals as follows, the figures indicating the number of pounds per acre of each substance used: Superphosphate of lime, 350; sulphate of potash, 200; sulphate of soda, 100; sulphate of magnesia, 100. These alternate applications were so made that during the year in which one plot received ammonia salts the other received minerals. The result is two complete series of results from thirty-eight continuous harvests. The one series from land treated with ammonia salts for the growth of the crop harvested, and with mixed minerals for the harvest of the year before; the other from land treated with mixed minerals for the crop harvested but with ammonia salts for the preceding crop. There is thus an opportunity for comparing the after-effect of nitrogen, when applied in ammonia salts, and of minerals. Below is given the average yield for the thirty-eight years in bushels of grain and hundred-weight of straw per acre and, for comparison, the results obtained from plots unmanured and from plots continuously treated with a similar mixture of minerals alone, with ammonia salts alone, and with minerals and ammonia salts combined, the amount of each substance used being the same in each case.

AVERAGE YIELDS OF CERTAIN WHEAT PLOTS AT ROTHAMSTEAD, 1852-89.

Kind of Manure.	Bushels of Grain.	Cwt. of Straw.
Unmanured	13⅛	11⅝
Mixed Minerals alone, continuously	15	12½
Minerals alone, Ammonia Salts each previous year	15⅛	13⅛
Ammonia Salts alone, continuously	20¼	18⅛
Ammonia Salts alone, Minerals each previous year	30¼	29⅝
Mixed Minerals and Ammonia Salts, continuously	32¾	33

We here see an average increase of but one-eighth bushel of grain per acre as the result of the use of ammonia salts the preceding year whereas the minerals under like conditions produce an average increase of 10 bushels per acre. There are other results which show distinctly in 1890 the effect of minerals applied in 1848 and 1850 upon land continuously manured yearly with 400 pounds of ammonia salts, the results being compared with those from a plot similarly manured with ammonia salts each year but which had received no minerals since 1844 when both plots received the same amount. There are still other and even more direct data showing the accumulation of minerals in soils when applied as manures. Space forbids giving them here.

It can hardly be argued that in the above mentioned experiments the ammonia salts were applied in such limited quantity that the nitrogen was all consumed and none remained for the succeeding crops, for while each 400 pounds of that manure contained about 43 pounds of actual nitrogen, the amount of nitrogen in the increase of harvest over that from the plot continuously manured with minerals was, as computed from what seem unquestionable data, less than 30 pounds per acre, in fact less than two-thirds of the total amount applied. We know, too, that a certain amount of nitrogen is each year washed from the soil.

There are certain matters connected with the nitrogen of slowly decomposing plant substances in the soil which should receive more attention in this connection. In fact, upon this more than upon almost any other single factor seems to depend the rate of exhaustion of the soil for most farm crops. As regards the ash constituents of such substances, they will for our present purpose be considered as standing in the same relation to the soil as when applied to it in the form of mineral salts or as they there exist as parts of mineral compounds. Whatever other relations they, as they exist in decaying organic matters, may possibly hold to the growing plant will not affect our present argument.

At Rothamstead, both with barley and with wheat, there was upon the plots continuously unmanured a considerable decrease in the yield of produce during the last nineteen over the first nineteen years of the experiment. In the table next below is given the per cent decrease in wheat harvested during the last nineteen years as compared with the first nineteen years, expressed in per cent of the average yield of the first period. The comparison is made upon the grain alone though equally apparent in the straw. Thus, the average yield of the plot continuously unmanured was for the first nineteen years 14⅞ bushels per acre, while for the second period it was 11⅛ bushels, or a decrease of 3¾ bushels, which, expressed in per cent of 14⅞ bushels, is 25.2 per cent.

COMPARATIVE DECREASE IN YIELD OF CERTAIN ROTHAMSTEAD WHEAT PLOTS.

Kind of Manuring.	Bushels Grain. Average 38 Yrs.	Per cent Decrease, 2d half against 1st.
Unmanured continuously	13	25.2
400 pounds Ammonia Salts each year	20¼	25.4
Mixed Minerals alone each year	15	25.4
Mixed Minerals and 200 pounds Ammonia Salts	24	22.2
Mixed Minerals and 400 pounds Ammonia Salts	32¾	17.4
Mixed Minerals and 600 pounds Ammonia Salts	36	12.8
14 tons Farmyard Manure each year	34	9.1

It will be seen from the above that the per cent of decrease was nearly equal upon the plots continuously unmanured, treated with minerals alone or with ammonia salts alone. The exhaustive effects of the ammonia salts continuously applied alone is still more apparent when the yields during individual years are considered. During certain of the latter years of the experiment the produce from this plot has been even less than that from the plot continuously unmanured. This did not occur during the first twenty or more years of the experiment even in the most unfavorable seasons. Indeed during the first few years the results from this plot nearly or quite equaled those from the plot treated with mixed minerals and 400 pounds of ammonia salts.

Where minerals and ammonia salts were applied together the percentage of decrease diminishes as the amount of ammonia salts increases. The least percentage decrease shown in the table occurred when farmyard manure was used.

There are other instances when the falling off was even less than with farmyard manure. These occurred when a quantity of nitrogen was each year so applied as to be most serviceable. A careful study of the results of this experiment makes it apparent that the falling off in yield when little or no nitrogen was used was due to the decrease of nitrogen compounds originally existing in the soil.

A comparison of the decrease in yield of the barley plots leads us to the same conclusion as that shown in case of the wheat experiments above. A comparison of but two of them will be here stated. For convenience it will be made by stating the average produce of the second period in per cent of that of the first, instead of showing the per cent decrease as with wheat above.

COMPARISON OF PRODUCE FROM CERTAIN ROTHAMSTEAD BARLEY PLOTS.

	Bushels Grain. Average 38 years.	Average Produce, 2d 19 Years or Per Cent of Produce 1st 19 Years.	
		Grain.	Straw.
Unmanured	16¾	65.8	59.0
Mixed Minerals alone	22½	63.3	60.9
200 pounds Ammonia Salts alone	29⅛	80.6	75 5
14 tons Farmyard Manure	48⅝	102.6	107.3

Here, while there is a large falling off in produce on the first three plots mentioned, there is in case of the farmyard manure an actual increase in the produce of the second period over the first.

In 1871 the barley plot previously manured with farmyard manure at the rate of 14 tons per acre was divided into halves. The one half has received the same rate of manure each year while the other has been left unmanured. In the following table certain comparisons are made of the produce of this and a few others.

COMPARISON OF CERTAIN ROTHAMSTEAD BARLEY PLOTS, YIELD PER ACRE.

Kind of Manuring.	Average 19 Years, 1871-89. Bushels Grain.	Yield in 1890. Bushels Grain.
Unmanured 1852, and since	13¼	13
Mixed Minerals, 1852 and each year since	17½	17¾
Farmyard Manure 1852-71, no Manure since	30¼*	22⅜
Farmyard Manure 1852, and each year since	49¼	53

We may here see an average increase of 17 bushels of barley per acre over the plot continuously unmanured, extending through a period of eighteen years after the last application of the farmyard manure. The effect is still markedly apparent in the nineteenth year. It is apparently due to the accumulation of plant food in the soil. That this increase is not entirely due to the ash material is seen when the produce of the plot in question is compared with that from the plot receiving each year an abundance of mixed minerals.

---

* Average for eighteen years only.

In 1883 samples of soil of the different plots of the experimental barley field at Rothamstead were collected for analysis. In these samples the total carbon and nitrogen present and the nitrogen in nitrates was determined. I take the liberty of here reproducing a table prepared from the results obtained, by Dr. Warrington, of Rothamstead, for use in his paper, "On some of the Changes which Nitrogenous Matter Undergoes within the Soil." It brings out forcibly some points of apparent importance in this connection, showing the accumulation of combined nitrogen to the soil, as brought about by the addition of organic matters and the relation of this to the formation of nitrates.

Annual Manuring, and Average Produce of Land continuously cropped with Barley during thirty years. Also the percentage of Nitrogen and Carbon, and the quantity of Nitrogen as Nitrates per acre found in the soil at the end of that period:

Plot 1 o.	Plot 2 o.	Plot 1A.	Plot 2A.	Plot 1C.	Plot 7^2.
No Manure.	Superphosphate, 3½ cwt.	Ammonium salts, 200 lbs.	Superphosphate, 3½ cwt. Ammonium salts, 200 lbs.	Rape cake, 1,000 lbs.	Farmyard manure, 14 tons.
Average Annual Produce (Corn and Straw) per acre, 1852-81.					
lbs. 2,150	lbs. 2,604	lbs. 3,609	lbs. 5,368	lbs. 5,243	lbs. 6,040
Nitrogen per cent in First 9 Inches of Soil, March, 1882.					
0.093	0.090	0.090	0.102	0.123	0.211
Carbon per cent in First 9 Inches of Soil, March, 1882.					
1.021	0.957	1.026	1.060	1.327	2.486
Nitrogen as Nitrates per acre in First 27 Inches of Soil, March, 1882.					
lbs. 16.9	lbs. 19.2	lbs. 22.9	lbs. 27.6	lbs. 32.1	lbs. 45.5

We may from this table see a very much larger amount both of total nitrogen and of carbon upon the plot that has been continuously treated with farmyard manure than upon any of the others. This is what we would expect from what we otherwise know of the accumulation of the organic matter in the soil from such manure. The two other plots ranking next in these constituents are 1C and 2A. Of these the former has continuously received a manuring of rape cake, an article similar in its nature to cotton seed meal. The latter has yielded a produce second, in the instances above shown, only to that of farmyard manure, and more than twice that from plot 20. It is natural to suppose that there would be a greater accumulation of organic matter from roots owing to this increase of crop.

As regards the nitrogen in nitrates there is in general, with exceptions which can be accounted for, the larger amounts in the soil of those plots showing the greatest per cent of organic nitrogen. We can thus understand how it is that the barley plot continuously manured with farmyard manure has increased in its annual produce while the others have diminished. We can also understand how the after-effect of barnyard manure, as mentioned above, has been such as to increase the produce of barley in the nineteenth year after its last application. Go one step farther and we can also understand how the plot which has received no manure has after thirty-eight years of continuous cropping yielded a harvest of 13 bushels of barley per acre, and how unmanured land after forty-six years of continuous cropping with wheat yielded in 1889, 12¼ bushels of grain per acre. The nitrogen has been supplied for the most part by the slow decay of the organic matter of the soil.

Experiments have also been made upon the farm of Sir J. B. Lawes with permanent meadow lands variously treated. Somewhere in the 50's one of his fields was seeded with various meadow grasses, clovers, etc. There was thus a mixture of those two great classes of plants which play so important a part in agriculture—the grasses and the legumes. Careful estimates and determinations of the amounts of combined nitrogen in the surface soil of this meadow land have been made, the last samples being collected in 1888. A careful comparison by Sir Lawes shows the amount of soil nitrogen to have nearly doubled from the beginning of the experiment up to that date, the amount then present in the first 9 inches being about 0.24 per cent, equivalent to about 4,600 pounds per acre. By comparing the amount of nitrogen annually removed in crops of hay with that added in manures and such other possible sources as the nitric acid and ammonia of the atmosphere, he still finds a "greater or less balance of gain." There is in this experiment no means of estimating the amount of the possible loss of combined nitrogen that may have occurred through drainage and certain other possible sources. Owing to the large amounts of active roots in the soil the loss through drainage was probably small.

Below are given some interesting figures concerning another permanent meadow at Rothamstead. These show a comparison of the average yield for two consecutive periods of ten years each, from certain plots differently manured. Over these periods the first crop only was cut and the remainder of the growth was pastured off. The figures given indicate the average yield of the second period in per cent of the average yield of the first. At the right is given the average annual produce as hay for the whole twenty years.

COMPARISON OF SOME PLOTS OF PERMANENT MEADOW LAND AT ROTHAMSTEAD.

Kind of Manuring.	Average Produce 1866-75 in Per Cent of Average Produce 1856-65.	Average Hay 1856-75 in Cwt. Per Acre.
Unmanured continuously	90.1	22⅝
Ammonia Salts alone each year	72.1	26¼
Mixed Minerals alone each year	108.5	35¼
Minerals and Ammonia Salts each year	90.0	51

The marked falling off in produce on the plot continuously treated with ammonia salts stands out in marked distinction from the gain upon the plot continuously treated with mixed minerals. The exhaustion of ash material is here clearly indicated. We saw a marked decrease in yield in those cases where minerals are used alone for either wheat or barley. Here, when we have plants of the same character of growth intermingled with certain leguminous plants we find an increase in the annual produce. There has apparently, then, been no falling off in the available nitrogen.

In each of the years 1862, 1867, 1872 and 1877 a complete separation was made of the different species of plants growing upon the various plots of the permanent meadow referred to above. The average of a few of the results are given in a table below. As there shown the different species have been divided into three groups: The grasses, the leguminous plants and a mixture of such others as occurred. The first portion of the table shows the proportion by weight of each of these different groups in per cent of the total weight of produce. The second portion shows the actual number of pounds per acre, as hay, for all the plants of each group together with the total produce per acre for each of the plots given.

COMPARISON OF DIFFERENT HERBAGE UPON CERTAIN DIFFERENTLY MANURED PLOTS OF PERMANENT MEADOW AT ROTHAMSTEAD. AVERAGE OF 1862, 1867, 1872, AND 1877.

Name of Group.	Plot 3.	Plot 5.	Plot 7.	Plot 9.
	Unmanured.	400 pounds Ammonia Salts.	Mixed Minerals.	Minerals and Ammonia Salts.
Weight of each Group in per cent of Total Produce.				
Gramineous Herbage	67.55	84.23	61.03	87.96
Leguminous Herbage	8.01	0.28	23.06	0.18
Miscellaneous Herbage	24.44	15.49	15.91	11.86
Weight of each Group in Pounds per Acre.				
Gramineous Herbage	1,743	2,652	2,808	5,182
Leguminous Herbage	202	8	1,026	11
Miscellaneous Herbage	653	496	721	681
Total Herbage	2,598	3,157	4,555	5,874

We have, here, forcibly brought out a difference in the feeding habits of the two great classes of farm plants,—the Gramineæ (grains, grasses, etc.) and the Leguminoseæ (clovers, vetches, peas, etc.). The relative proportions of these two classes of plants when growing together markedly vary according to the nature of the food supply. Leaving out any consideration of the miscellaneous herbage which varies but little for the plots in question, the grasses have become almost the exclusive herbage on the plots to which ammonia salts were applied while the leguminous plants acquire a large proportion on the plots receiving minerals but no nitrogen.

It was noted below the table second above (page 115) that while there was a marked falling off during the latter years of the experiment, in the total produce of the plot receiving nitrogen but no minerals, there was an increase in the plot which received minerals alone but no nitrogen. This latter is the plot bearing the greatest proportion of leguminous plants but the increase of produce did not by any means lie entirely in the plants of this order. On the contrary "Calling to our aid the results of the partial separations made in several intermediate and succeeding years, it must be concluded that the grasses have increased in their proportion during the later years, whilst the leguminoseæ have not sustained the tendency to increase so prominently in the later as in the earlier years. *In actual amount per acre, too, the grasses have of late years increased, and the leguminoseæ—diminished."

This increase in the produce of grasses stands out in marked contrast to the diminished yield during the later years of the continuous growth of wheat and barley with mixed minerals alone, as noted above. On the contrary it stands in close relation to the increase in the produce of barley brought about by the continuous growth of barnyard manure. Our knowledge of the similarity of the feeding habits of the grasses and grains seems to justify this comparison notwithstanding the fact that the grasses are grown for their stem and leaves while the cereals are grown mainly for their grain. What, with the grasses, has been the source of the available nitrogen which has produced the increase?

It is the common experience both in this country and in Europe that the growth of clover upon land leaves the soil in an excellent condition for wheat. It seems somewhat remarkable that an average crop of clover while containing in the produce removed from the soil nearly three times the amount of nitrogen removed in a crop of wheat (straw included), still leaves more available nitrogen in the soil for a succeeding wheat crop than would otherwise have been present. For a time this was thought by some to be due to the power of clover to obtain from humus a quantity of nitrogen which was not accessible to wheat. It has not yet been proven that this may not in part be true. It is now known that leguminous plants (but not grains and grasses) have, under certain conditions, a method of obtaining for their use a quantity of free nitrogen from the atmosphere. There are strong reasons for believing that these conditions are attained in the soil. Granting it we have an explanation of the important benefits derived from the use of leguminous in connection or alteration with other farm crops. Upon removal of the usual above ground portion of clover there still remains to the soil a comparatively very large amount of root and stubble which upon decay yield nitrogen in the form of nitrates just as does barnyard manure. Or if we choose to plow under the above ground portion, either before or after it has partially decayed, we still further increase the amount of humus in the soil and consequently the amount of nitrogen to be gradually set free for the use of plants.

Cotton seems to stand in much the same relations to nitrogenous manures and to leguminous plants as do grains and grasses, and several experiments have been made in various places which have shown a decided increase in the yield of cotton on soils which had grown cowpeas the previous year, especially in those instances where the tops had been plowed under, either without being removed from the soil or when returned to it after being used for hay and converted into barnyard manure.

---

*Considerations of miscellaneous herbage are for clearness here omitted.

The testimony of competent witnesses familiar with the growth of the cowpea is that it is a valuable preparatory crop for both cotton and grains. Its action on worn out soils is to replenish them with a supply of organic matter. The value of clover in bringing up the condition of "run down" lands is familiar to many. The exhaustion of land which occurs from the failure to grow crops of this kind is hardly less familiar. These facts bring us to a brief summary of important principles in soil exhaustion.

Nitrogen compounds of the soil, whatever their original form, are in time converted into nitrates which are readily soluble in water and which will be washed from the soil unless taken up by the roots of the plants. The forms of nitrogen compounds which are most readily converted into nitrates are ammonia salts and certain plant and animal matters. Those of coarse plant matters and of humus are less readily changed but the process is going on continuously during those portions of the year in which the soil is sufficiently warm. So far as known the rate of this change is increased only by the use of such manures as lime and ashes. It is not known to be in the power of any plant to hasten that change however great its immediate needs for combined nitrogen and further there are good reasons for believing that plants, or at least most of them, cannot avail themselves of the nitrogen of humus before such change. It has also been pointed out that though phosphoric acid and potash be added to a soil in a soluble condition they are soon fixed against drainage. About the only source of loss to the soil of these latter substances is by removal in crops.

While the exhaustion of the soil in the more important ash constituents of plants lies mainly in the amount of those substances removed in crops the exhaustion in nitrogen depends not upon the amount of that substance so removed, but upon the amount retained in the crop residue. There are strong reasons for believing that with leguminous crops the amount so retained will be considerably in excess of any that may be lost during their growth, while with most other farm crops the reverse is true.

Barnyard manure, when used in sufficient quantities, will take the place of leguminous crops in maintaining the humus of the soil, and we have seen that sufficient quantities of concentrated artificial manures will, when applied from year to year, take the place of barnyard manure. The original cost of such manures is considerable; their successful use requires much skill; there is much danger of loss from various causes and with the present large area of cheap lands in this State, the high rates of transportation and the low price of the staple farm products, it is doubtful if complete artificial manures can be profitably purchased here for general farm crops. When through the marked deficiency of one and sometimes two of the chief fertilizer elements those otherwise available remain useless, the deficiency may perhaps be profitably supplied by the purchase of concentrated manures containing it.

Leguminous crops are seldom benefited by the nitrogen of manures. They depend for their growth upon a considerable supply of ash material, especially potash, and to a less degree, phosphoric acid. When not present in the soil these may be supplied at a comparatively low cost, and if not used by the crop for which applied are a permanent addition to the soil. If used for leguminous crops, they may assist in collecting a supply of nitrogen which, together with the ash constituents taken up by this crop, will soon become available for the use of succeeding crops.

G. L. TELLER.

STRAWBERRIES.

By J. T. Stinson.

Growing strawberries for market and for home use is attracting attention in many sections of the State where this fruit has not been grown to any extent previous to this time, and it is intended to furnish some information herewith on that subject for the beginners.

This increased interest in strawberry growing is caused by the good prices berries have brought in recent years. The acreage was doubled in some sections this year, and in others the increase perhaps was even greater. Early berries have brought the highest prices as a rule, but in the northwest section of the State the medium and late ones are as extensively grown as the early. The large berries have generally brought good prices. Late berries are grown to some extent in this section to ship South. There are only a few points in the south half of the State where berries are grown for shipment, except it be to a nearby market, but there are many sections in that portion of the State where strawberry growing could be profitably carried on.

Strawberries for the Table. This Bulletin is not intended solely for those beginning strawberry growing for market, but it is hoped that some may be led to grow this fruit for the home table. The number of farmers' tables that have strawberries on them regularly during the strawberry season are few, compared with the large number that do not have them.

It takes but a small patch of strawberries to supply an average-sized family with berries from the beginning of the season until the end; the cost of such a supply from the home garden is very slight. Strawberries can be successfully grown in all sections of the State for home use, and no home should be without them.

It is a fact that the best that can be done in furnishing information through the medium of a Bulletin is to simply give results, and let each grower test the different methods and ascertain what is best suited to his conditions; this will hold true with methods of culture as well as with varieties. It is the aim in publishing this Bulletin on strawberries to give some general information regarding strawberry growing in this State, as well as the results obtained here at the Station. It is true that the best knowledge of the strawberry business or any other fruit growing business is obtained by individual experience. The conditions are so unlike that it is difficult to give any general rules.

For the purpose of testing a number of varieties in more than one section, trial plots were planted at Van Buren and at Pine Bluff. Mr.

Wm. T. Simpson has charge of the test plots at Pine Bluff, and his report on some of the varieties is given in this Bulletin. The trial plots at Van Buren are on the farm of Mr. Frank Smeltzer. The notes on the varieties there were used with the notes taken here, and are found on subsequent pages. It is fully realized that a test at one point is not of as much value regarding any certain variety as a test of the same variety at several places. Variety testing, where done by growers in different sections, is valuable, and it is the aim of the Experiment Station to secure results from these trial plots and publish them in future bulletins.

When selecting varieties for planting, it is advisable to select those that are known to do well in the immediate locality where the planting is to be done. There are a number of varieties that may be considered as standards that do well in many localities, and under different conditions. It is a good plan for the beginner to leave the testing of new varieties to successful growers who have had experience, because many failures in fruit growing may be attributed to the effort to try every new variety that is offered annually. Of the many new varieties of strawberries that have been offered for sale at fancy prices within recent years but few of them have proven of any especial value, and then only in a few localities.

NOTES ON VARIETIES.

Aroma (Perfect). Fine plant, medium to large leaf, rather dark in color. Berry large to extra large, uniform, round, somewhat pointed, firm. Yield fairly good. This is a promising berry and may prove valuable for this section. Season late.

Barton's Eclipse (Imperfect). This variety has held its own again this season, producing a good crop of large berries. It is a fairly good shipper, and a mistake will not be made in planting it. The berry has faults, however, one is that it does not ripen evenly.

Bedar Wood (Perfect). Plants small and badly rusted. A good crop of berries, but plants were unable to mature them. It does fairly well here some seasons, but is not desirable for a dry season. There are other varieties that will take its place which will give regular crops every year.

Belle (Perfect). A fair crop of medium to large berries. It does not bear heavy enough to be profitable.

Bisel (Imperfect). A fair crop; some very good berries, but not heavy enough yield.

Brandywine (Perfect). Large, dark leaves; foliage stands up well. Berries large, firm; in shape they resemble Gandy Belle. It bore a good crop this year and is fairly promising.

Brunette (Perfect). Plants strong, leaves large, medium to dark color, attacked some by rust. Yield fair, berries medium size, firm. It is not promising, but may prove of more value on further trial.

Bubach No. 5 (Imperfect). This variety has done uniformly well in nearly all fields in this section this year. It has given large yields and the berries have brought a good price in the market. While it is a soft berry for shipment, nevertheless there have been few complaints of it reaching the markets in bad condition.

Clyde (Perfect). This is the most promising new berry that we have had on the Station grounds on trial during the last few years. If it does as well during succeeding years as it has on our trial plots this year, it can be recommended safely for general culture. It has fine foliage and is a good plant producer. The berries are of good size and uniform in shape. It is medium early. Season with Crescent, beginning to ripen a few days later than that standard variety. It gave the heaviest yield this year of any variety on our trial plots at Van Buren. It promises well north of this. We have reports of it doing finely at Monett, Mo.

Crescent (Imperfect). This variety is too well known to need mention here. Where a fair sized berry is desired it probably has no equal. It is grown for market extensively in all sections of the State.

Cyclone (Perfect). It gave us a good crop of fine berries. Berries firm and good size. It is worthy of further trial and may prove valuable as a market variety, but should be planted sparingly until further tested.

Enormous (Imperfect). Fair to a good yield. Berries good size, some very large. It is not promising; there are better berries for this section and it will be discarded.

Enhance (Perfect). Plants medium size, leaf small to medium. It yields a good crop, but the berries do not ripen evenly, one side is ripe while the other is quite green. It is rough in shape, and aside from these two faults would be desirable for this section, as it yields a good crop.

Gandy (Perfect). This is the standard for late berries for this section. It produces a large firm berry and may be relied upon for a crop every year. Although it cannot be called a heavy bearer, it gives a better crop with hill culture than it does in a matted row.

Ganay Belle (Perfect). A good plant producer. Berries large but rather rough. It has not done as well this year here as it did last. Will be discarded.

Gardner (Perfect). Plants medium size; healthy. Berries average large, somewhat uneven in shape, of good color, rather soft and of good flavor. This variety is promising and deserves further testing. It may prove valuable for home market.

Giant (Perfect). Plants medium size. Berries are large and a heavy crop was produced this year. It is a late berry, season about with Gandy. Berries are firm and round, some slightly flattened, but uniform in size. This is a promising late berry and may prove valuable for this section. It has one fault, however, and that is the plants are not of sufficient size to shade the fruit; in this respect it may do better another year. Berries hold up well when shipped.

Glen Mary (Perfect). But few plants were left for this year's fruiting, both here and at Van Buren, but the plants set a good crop of fruit, though not enough to insure it being a profitable berry for this section.

Greenville (Imperfect). Foliage heavy, leaves dark and large. Produced a heavy crop of fine berries. Berry large to very large, of rather a light color. It is classed as a soft berry, but is firm enough for shipping, and went into the market in good shape. In our test of a number of varieties regarding their keeping it held up better than Bubach. This is a promising berry and it will be safe for growers to plant it. Season about with Bubach.

Haverland (Imperfect). Plants strong, yield good to very good; berry large and pointed, rather soft, but it ships well for a large berry. This variety is grown extensively by some growers at Sarcoxie, Mo., for shipment. It has always given a good crop here at the Station, and where large berries are desired it is a standard.

Holland (Imperfect). Plants large and a good plant producer; it is productive; large berries and uniform in shape. It is a promising variety. The variety was originated at Judsonia, Ark. It gave a good crop at Van Buren this year, better than it did here.

Hoffman (Perfect). While this variety does well in some sections of the State, and has been reported on by some growers as doing well with them, we have been unable here at the Experiment Station to get a satisfactory crop of it. Two or three satisfactory pickings are all we have been able to get.

Lady Thompson (Perfect). Large plants and leaves, foliage light color. It gave a fair crop of fine early berries, but with us it did not yield heavy enough for general culture. On our trial plots at Van Buren the yield was fair to good. It is reported as doing well in some sections, and may be valuable as an early fancy market berry.

Leader (Perfect). This variety has given uniformly good crops on the Station grounds until the last two years. The foliage has been damaged by rust during the last two years, and we have been unable to get a satisfactory crop.

Lovett (Perfect). Good plants, medium to large leaf, dark color. It gives a good yield of berries ranging from small to large. The large berries coxcomb. It is a good pollen producer, and is a safe berry to plant. but should be tested by the grower in his own field before being planted extensively. It is a good fertilizer for Warfield, but is small to plant with large berries.

Marshal (Perfect). Strong plants, foliage dark, slightly attacked by leaf rust. Berries large, uniform, round, and pointed; very dark rich color; ripens evenly. Yield fair to good. It may prove a desirable variety, but further trial will be necessary to decide upon its merits as a field berry.

Mary (Imperfect). Plants strong, leaf medium to large, dark, healthy. Yield heavy, berries large to very large, some of them immense size; only fairly firm. This variety produced a heavy crop at Sarcoxie, Mo., this year. Mr. D. McNallie has it on trial there and is well pleased with it. It may prove valuable for a fancy market berry.

Meek's Early (Perfect). This variety is a splendid plant producer, large healthy plants, but a scarcity of fruit. It does not equal Michel except as a plant producer. It will not pay to cultivate it in this section.

Michel (Perfect). This is the standard early berry so far for this State. In some sections it is planted more extensively than all others. Mr. P. D. Scott, of Van Buren, an extensive grower of this variety, says that 90 per cent of the berries that will be shipped from Van Buren next spring will be Michel's Early. It is a good fertilizer for Crescent.

Parker Earle (Perfect). This variety has done only fairly well here on the Station grounds, but it has done better at other points in the State. Mr. Simpson at Pine Bluff had a very fine field of Parker Earle this year. It produced a wonderful crop there, and was a fine market berry. It does better with hill culture than in the matted row.

Paris King (Perfect). Plants medium, foliage medium to light color, slightly damaged by rust. Berries medium to large, of good color. It does not come up to other varieties in the field, and has not given as good results as it promised the first two years that it was tested here.

Princeton Chief (Imperfect). A good yield of medium to large berries, but they were rough and uneven. This variety will be given further trial.

Rio (Perfect). Good stand of plants, healthy, fair to good crop of early to medium early berries. The early pickings gave the best berries; the later berries were uneven.

Robinson (Perfect). Fair stand of plants. Gave a fair yield of medium to large berries. It is not promising.

Staples (Perfect). A good stand of plants. It produced a good crop of berries both here and at Van Buren. The berries are small but uniform; season about with Warfield. It is a good pollen producer, and would be a desirable variety to plant with Warfield as a fertilizer.

Splendid (Perfect). A fair yield of fine berries. This variety usually gives a fair crop, but does not yield heavy enough for general culture.

Sunrise (Imperfect). A good stand of plants; made 75 per cent of a stand last year in spite of the drouth. Gave a fair to good crop of medium to large berries. Berries uniform but rather soft.

Sunnyside (Perfect). A fair stand of plants; plants medium size; yield good to very good; berries moderately firm.

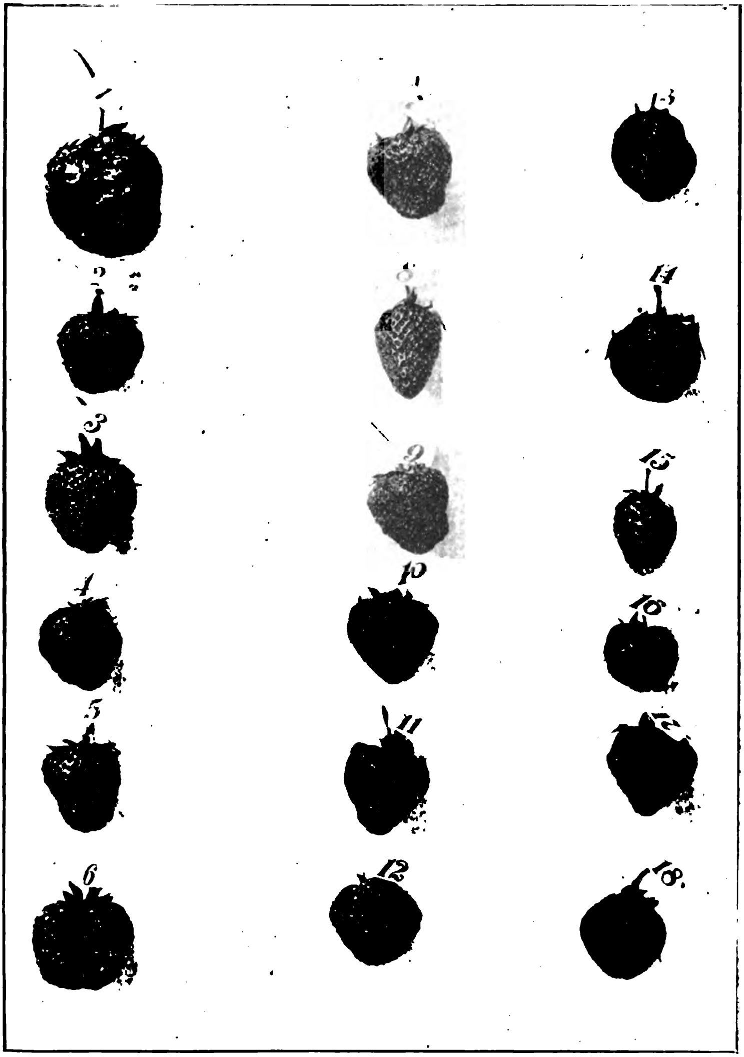
Tennessee Prolific (Perfect). It is a good plant producer, plants healthy, foliage rather dark. Berries large and inclined to be rough; firm, and of good color. It is a promising variety for this section. It gave a good crop of medium to large berries on the trial grounds at Van Buren.

Tubbs (Perfect). A good stand of plants, but damaged some by rust. Berries medium to large, uniform. A fair yield. Its tendency to rust makes it undesirable for field culture, but this may not occur in all sections.

Warfield (Imperfect). This variety is well known in this State. It has never given us satisfactory crops here on the Station grounds, but in some sections it is said to give good crops. It is planted extensively in some of the berry fields in south Missouri, and is being planted by some growers in this State. It will be well to test it thoroughly before planting largely of it; at least our experience here would indicate as much.

William Belt (Perfect). The plants on the Station trial grounds all died last year during the drouth. At Van Buren a fair stand of plants, but only a fair yield. Foliage damaged by rust.

Woolverton (Perfect). Plants small to medium, damaged some by leaf rust. It gave a heavy crop this year. Berries range from small to large, larger berries ripening uneven; firm. It is a good pollen producer and a safe berry to plant.



No. I.

Varieties of strawberries one-third natural size.

No. 1. Mary.
No. 2. Sunnyside.
No. 3. Aroma.
No. 4. Rio.
No. 5. Barton's Eclipse.
No. 6. Bubach.
No. 7. Greenville.
No. 8. Haverland.
No. 9. Enhance.
No. 10. Glen Mary.
No. 11. Tubbs.
No. 12. Giant.
No. 13. Marshall.
No. 14. Brandywine.
No. 15. Gardner.
No. 16. Sunrise.
No. 17. Wm. Belt.
No. 18. Tenn. Prolific.

Some results regarding varieties reported in previous bulletins from this Station are here given. It is seen from these results that some of the varieties recommended for planting then are now discarded, while others then recommended are yet standard varieties.

Bulletin No. 13, August, 1890. The following is a summary of some of the results arrived at from the testing at that time. These results were given after one year's testing. There were seventy-one varieties in the test plots at that time:

For medium early berries the most productive were Daisy, Cloud and Crescent.

The three medium late berries giving the best yield were Warfield No. 2, Bubach No. 5, and Louise.

The three most productive late varieties were Glendale, Eureka and Haverland.

Of those given above, that are now discarded, are Daisy, Cloud, Louise and Glendale. The following is a list of the varieties on the Station grounds on test during the season of 1890 that have since been discarded:

Jersey Queen,
Jas. Vick,
Pres. Lincoln,
Aunt Smith,
Prince of Berries,
Early Canada,
Mt. Vernon,
Parry,
Mrs. Garfield,
Ohio,
Pearl,
Miami,
Burt,
Kentucky,
Finch Seedling,
Warner,
Jewell,
Crystal City,
Big Bob,
May King,
Hart's Minn.,
Miner,
Logan,
Ontario,
Carmichael,
Lady Rusk,
Mam. Seedling,
Monarch,
Jessie,
Iron Clad,
Crimson Cluster,
Manchester,
Belmont,
Champion,
Henderson,
Gypsy,
Monmouth,
Gold,
Oregon Everbearing,
Bidwell,
Wilson,
Captain Jack,
Atlantic,
Daniel Boone,
Piper,
Legal Tender,
Windsor Chief,
Primo,
Bubach No. 132,
Clara,
Warfield No. 4.

Bulletin No. 17, October, 1891. Notes were given on seventeen of the most promising varieties. They were:

Bubach No. 5,
Crescent,
Eureka,
Michel's Early,
Warfield No. 2,
Crystal City,
Bessie,
Captain Jack,
Haverland,
Stayman's Nos. 1 & 2,
May King,
Van Deman,
Cloud Seedling,
Crawford,
Hoffman,
Gandy.

Of those given above we have now discarded Bessie, May King, Crawford, Captain Jack, Van Deman and Hoffman.

Bulletin No. 39, January, 1896. Notes are given on some of the leading varieties, those giving the best results on the Station grounds for the two years 1894 and 1895. The number of varieties in the Station plots that fruited were eighty. The varieties doing best were Barton's Eclipse, Bedar Wood, Bubach No. 5, Crescent, Eureka, Enhance, Gandy, Haverland, Meek's Early, Michel's Early, Parker Earle, Shuster's Gem, Stayman's

No. 1, Warfield No. 2, and Woolverton. With a few exceptions this list is considered a good one. Meek's Early is discarded, and Stayman's No. 1 and Shuster's Gem are not promising for general culture, although they both give good yields some years.

Those varieties that had little to recommend them at that time, and which were so reported in the Bulletin and that have since been discarded, are as follows:

Accomac,
Acme,
Alabama,
Auburn,
Beebe,
Bessie,
Bidwell,
Bomba,
Dayton,
Dew,
Edgar Queen,
Edward's Favorite,
E. P. Roe,
Farnsworth,
General Putnam,
Gillespie,
Gypsie,
Jessie,
May King,
Middlefield,
Monmouth,
Ore. Everbearing,
Pearl,
Pineapple,
Price,
Princess,
Regina,
Shaw,
Sterling,
Stevens,
Tippecanoe,
Walton,
Westbrook.

Bulletin No. 43, December, 1896. This Bulletin gave the results obtained from the Station plots for 1896, and reports from growers in several sections of the State. The number of varieties fruiting on the Station plots that year were sixty-seven, and notes on some of the newer varieties that were considered valuable for this section were given. Those giving the best results were: Tennessee Prolific, Paris King, Greenville, and Princeton Chief.

Those not desirable of the newer varieties were: Columbian, Enormous, Ivanhoe, Jay Gould, Mineola, and Timbrell.

Mr. Wm. T. Simpson, who has charge of the trial plots at Pine Bluff, has furnished the following report on varieties there:

> The strawberry crop at this place was a very satisfactory one, especially so where the plants were growing on moist land; they had a good stand, but on high dry soil the stand was badly reduced in 1896 by the extensive dry weather, though the plants that survived made a very satisfactory crop and sold at a fair price.
>
> *Meek's Early.* After another year's trial I have decided to discard this variety as it is not sufficiently productive to pay its way. Its foliage is all that could be desired, and the berry is at the very top as to quality, color, and shape, but it will not pay here for market.
>
> *Michel's Early.* This is still the leading extra early here, but it is not as productive as the ideal berry that we are looking for.
>
> *Columbian.* Another worthless variety where berries are the object, but it is a splendid plant maker, and resists drouth admirably.
>
> *Bedar Wood.* I think more of this berry of late years than formerly. The foliage blights some and is not very vigorous, but it piles up the berries very early in the season when berries are high. The quality is not first-class either, and the berries run small very fast if the weather is dry; but taking it all around I find it a very profitable berry.
>
> *May King.* This berry is being superseded by others of its season, still it has many good qualities to recommend it to the berry-grower.

Lady Thompson. Although this berry is a very few days behind the Michel in ripening I believe it will make the grower more money than any other early berry, as it resists drouth remarkably well and has preserved a perfect stand all through the drouth of this year. It is more productive than Michel, and the berry is of good size, perfect shape and more solid than most extra earlies. I am well pleased with it so far.

Bubach. Too well known to require any extended description. I have said a great deal in favor of the Bubach in former years, and I have nothing but praise for it. It is a grand mid-season berry and one that has come to stay sometime yet. I now use the Brandywine or Gandy for a fertilizer and with good culture it is very profitable.

Haverland. We can't yet do without this berry for a local market; too soft to ship any distance, but its berries are of the largest size, and its productiveness is wonderful. It must be picked every day. With good culture and fertilized with Brandywine it is a fancy berry, and a money maker, rather later than Bubach.

Tubbs. This berry has sustained its drouth resisting qualities through this dry season, and if it was more productive it would be an ideal mid-season, medium sized berry. Not a bad berry to plant.

Rio. Fine large berry and very early, ripening just after the Michel. Size and shape all right, but it lacks a little in the way of productiveness.

Shuster's Gem. I have been well pleased with this berry this year. It ripened its first berries before the Bubach, and continued to bear until the very latest. It was very prolific. The berries are a beautiful light red, and of very large size. It would only do for a local market as the berries are soft and would not stand shipment.

Cyclone. Good mid-season berry, solid and a good shipper, very prolific, but like the Haverland it bears its berries on a long stem that causes the berries to lie on the ground and rot if not mulched.

Clyde. Here is a berry that if it comes up next year with as many good qualities as it did this year, I shall discard everything else in its season. It was of enormous size with me this year, very prolific, very solid, good quality, and the berries were of perfect shape. It ought to make an admirable mid-season shipping berry.

Brandywine. This berry does not resist drouth as well as some varieties, but it is strictly a fancy berry of large size, productive enough to make it a very profitable berry. It ripens from medium to late. Berries are perfect in shape, are solid and ripen all over at once. The berries are borne on stiff stems that hold them from the ground. Best polenizer that I know of for mid-season to late imperfect blooming varieties.

Parker Earle. On moist, rich land this is a grand success, but on dry, poor land with neglect it will be a most miserable failure. With good culture the berries are very large with a neck; quality first-class. Rather soft for shipment, but an admirable berry for a local market where the above conditions are complied with. Mid-season to late; very productive.

Aroma. If this berry had the drouth resisting qualities of the Gandy it would at once supersede that old standby. But it burnt out very badly with me this season, where the Gandy maintained a perfect stand right by its side. It is more productive than Gandy, but the berries are not so solid and not so attractive.

Bismarck. Promising new berry of the Bubach type of foliage and with a perfect bloom. I have not yet had a chance to test its productiveness satisfactorily, but of what I have seen, I think highly of it.

I have a number of others that have some good qualities, but for some defects they have been given a back seat. I think these reported on are the cream of the lot. I am not ready to discard several of the older ones yet, such as Tennessee Prolific, Warfield Crescent and many others, but they are too well known to take up space describing them. The tendency in strawberry growing, both for shipment and a local market, is intensive culture and fancy berries.

The time is not very far off when the old fashioned grower with his matted bed of Crescent Seedling or Chas. Downing, with his boxes of small berries, will have to give place to his more progressive neighbor with his fine Brandywine or Gandy berries, raised with high culture and liberal manuring. There is more money now in strawberries than ever, to the progressive grower, but he must get up towards the top where competition is not yet in his way.

At the request of the Station, Jacob C. Bauer & Sons, of Judsonia, furnished the following report regarding some of the newer varieties that they have been testing.

In compliance with your request we report on the newer varieties of strawberries as tested by us, season 1897, and condition of plants, as they are at this date.

The past season was an unfortunate one on strawberries. To begin with a very severe drouth in 1896 followed by a destructive hail storm just as the plants were in bloom. After recovering from this we had an extended cold season that caused the majority of berries to rot or sour on the underside when ripening. We report on the newer varieties as they have behaved under these conditions.

Aroma (*Perfect*). This is the only late berry that we shall grow for market. It covers a period of from three to four weeks, and begins ripening ahead of Gandy, and continues to bear from a week to ten days later. You want to grow them on matted rows for best results, let them mat all they will. The secret of its prolonged bearing and retention of large size to the end of the season, lies in its blooming one plant here and there every day for three weeks, from four to eight berries to the plant. But taking the result as a whole they will fill more crates to the acre than Gandy. The largest, firm, high colored berries that we have ever grown. It is a grand, robust plant, adapted to dry seasons.

Bismarck (*Perfect*). We are the originators and introducers of this strawberry which proved satisfactory to the strawberry growers of the North and Southeast the past season. The only rival they have for it is the Clyde. It needs good strong soil, and let them mat all they will. They will respond with a beautiful crop of large, fine, highly flavored and glossy crimson colored berries, fit to ship anywhere. It is a seedling of Bubach polenized by Van Deman.

Lady Thompson (*Perfect*). A grand healthy plant of vigorous constitution, berries scarlet, even shaped and firm; size medium to very large; desirable, as it is a good long distance shipper. A good companion to Michel and Smeltzer.

Should we be confined to but five varieties our selection of the standard varieties up to date for both home and market would be as follows: Aroma, Bismarck, Michel, Tennessee Prolific and Lady Thompson. These would cover six weeks of bearing one season with another.

The most promising of the newer high priced varieties are the following: Excelsior, Mele and Tubbs, with the Excelsior in the lead for taking the position that Michel's Early now occupies. It is a seedling of Wilson taken from a field where Hoffman was grown alongside. It has the color and firmness of Hoffman with the productiveness of the Wilson, from two to three days earlier than Michel and twice its size.

Darling (Perfect). A seedling of Michel from Virginia, more productive, of same color, shape and consistency, an advance on the Michel.

Mele (Imperfect). A chance seedling from Kansas, enormous bearer, of Crescent sized berries, of the most vigorous constitution, a great drouth resister.

Tubbs (Perfect). We like this for its ability to resist drouth, and productiveness. We prefer it to Crescent any time.

The following are of no value here: Bouncer, Columb an, Erie, Ocean City and Eleanor. The following have succumbed to drouth and heat of this season: Glen Mary, Enormous, Brandywine, Howard, Morgan, Tennyson and Isabella.

The past season has been the hottest and dryest we have ever experienced, but one soaking rain from 1st of June up to beginning of November, forest trees dying from its effects. We kept our ground stirred all season with Planet, Jr., Strawberry Cultivator and horse hoes, right along the dryest time. The result is, we have a fair show for as good a crop as last year, maybe better.

The prospects for Judsonia and vicinity are for as large a crop as last year.

Mr. P. D. Scott, of Van Buren, says:

The Michel's Early or Michel is the only berry for this section in my opinion. First, the only money maker we have; second, it is the finest berry that grows for shipment or home use. It has the finest perfume, sweetest and most delicious taste (especially when you get the return from a few early crates) of any berry that grows in our section.

The Crescent is also a fine berry, yielding large crops of fine berries, but is a little late here for a market berry. The Downing is also used here as a fertilizer for the Crescent, and is a large, handsome berry. For late berries the Bubach and Gandy take the lead.

STRAWBERRY CULTURE.

While the strawberry is adaptable to a variety of soils and locations, different varieties require different soils and climate for best results. A soil that will give a good crop of potatoes or corn will, as a usual thing, yield a good crop of berries. New soils give better results than land that has been cropped for some time, especially if nothing has been added to this land to supply the plant food used by the crops. A good retentive loam, with not too much sand, gives good results. A sandy soil will give earlier berries, but a more retentive soil will give larger yields. The best location is one nearly level, but with enough slope so that the field will have natural drainage. Slopes are to be avoided unless they are terraced and put in condition to hold moisture.

Preparation of the Soil for Strawberries. This crop is expected to bring large returns and the preparation should be thorough. Deep plowing in the fall, using a subsoil plow to follow the turning plow, and shallow cross plowing in the spring, and then the surface soil put in fine tilth with harrows, gives the best results.

Better than summer plowing and harrowing is to grow a crop of cowpeas during the summer and turn them under in the fall, which destroys the weeds and adds a good supply of vegetable matter and plant food to the soil. It is important that the soil should be plowed deep, as a reservoir is thus made to hold the water that falls during the winter and spring months. It is also important that crops requiring clean culture such as corn, potatoes, and garden crops, be grown the previous year as they are of great advantage in putting the land in good condition and freeing it from weed seed. Cowpeas, however, answer the same purpose and add plant food to the soil besides. Where sod is plowed under it is very necessary to grow these crops to free it of insects, such as the white grub and other similar insects that do damage to the strawberry plants. It is advisable, where strawberries follow sod, to have at least two years of clean culture crops intervening. Where stable manure has been heavily applied, one crop of early Irish potatoes, followed by a crop of cowpeas planted immediately after the potatoes are dug and then plowed under in the fall, makes a good rotation. Cowpeas should be planted in drills about 2 feet apart to allow thorough cultivation during the summer. Red Clover is probably superior to cowpeas in adding vegetable matter and plant food to the soil, but it requires two seasons' growth for best results. If it can be done, it is always better to plant strawberries after clover with one intervening clean culture crop.

Vegetable Matter in the Soil. The advantage in having a good supply of vegetable matter in the soil for all crops, and especially for a strawberry crop, should be carefully considered by growers. Humus is of direct benefit to growing crops. It assists in holding the moisture in the soil, it contains plant food, it assists in putting the plant food in the soil in available form, and gives the mechanical condition to it that is necessary for best results.

Humus is decaying vegetable matter, and is obtained by plowing under vegetable matter of any kind. There are certain crops that may be grown to furnish this necessary supply of vegetable matter; and it may be here stated that all upland soils which have been under careless cultivation for some time are lacking in vegetable matter. One of the best crops for our strawberry sections, for this purpose, is one or more crops of cowpeas turned under in the fall. Other leguminous crops also furnish vegetable matter as well as a liberal supply of plant food.

When stable manure is to be plowed under it is better to do it one year in advance of planting, otherwise the manure would not be well rotted and the weed seed contained in it would not be killed.

At the Station we have had good results by turning under rye that was sown after the soil was well prepared in the fall. It is a good cover crop during the winter and helps loosen the soil after being turned under in early spring besides supplying vegetable matter.

The use of phosphate and potash fertilizers is recommended for light soils in addition to the leguminous crops.

Cotton seed meal is used to a considerable extent as a fertilizer in some sections, and with good results.

Setting Plants. They are usually set in rows about 3½ feet apart, and 18 inches apart in drill, or they are set so that they can be cultivated crosswise. One method of planting is to plant in a furrow, made either by using a shovel plow or a small plow called a calf-tongue. The field is usually marked off with a common two-horse marker, which marks three rows at once, and if it is the intention to cultivate the field crosswise it is marked both ways. The small plow is run in advance of setting the plants, so that the soil is fresh and moist for setting. Plants are usually set by hand with the roots spread out so that they will come in contact with the soil. Care should be taken not to set them with the roots in a wad or bunch, nor should the crowns be below the surface; therefore the furrow for the plants should be shallow, but when it is deep the plants should be set on the side of the furrow, and in all cases the soil should be pressed tightly around the roots. A hoe may be used in setting plants, and some growers claim that much time can be saved by using it, and that equally good work is done. Careful growers use a line, and the plants are set with a flat dibble, thus making straight rows to facilitate cultivation. In some sections where the land is flat the plants are set on a straight ridge, made by throwing up a high ridge with turning plows and dragging down to a few inches above the surface level.

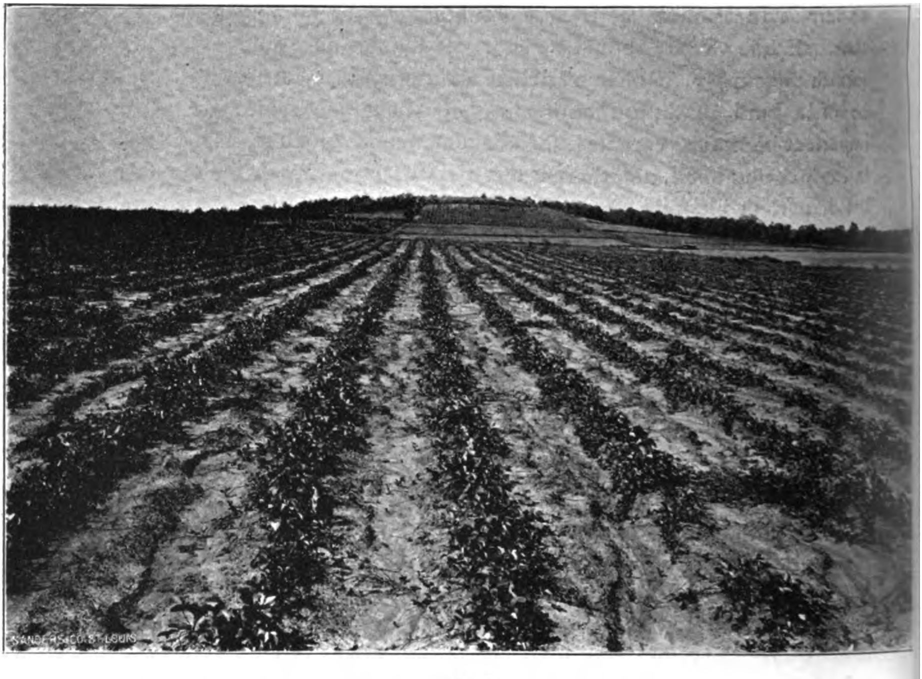
Strong healthy plants should always be selected for planting and they should be taken from beds planted the previous year. These beds should have good cultivation during the season to make strong plants with good roots. Plants from fields that are allowed to grow up to weeds are necessarily weak and will not give satisfactory results when planted. Poor plants are dear at any price and should never be planted if good ones can be obtained. Always keep plants protected from the sun and air until ready to set. Cut off all blooms from the newly set beds. None should be allowed to mature fruit the first season.

Perfect and Imperfect Blooming Varieties. The importance of planting perfect blooming varieties with the imperfect blooming sorts is well known, although it sometimes happens that a complaint is made that a strawberry patch will not bear fruit, and, upon investigation it is ascertained that the varieties are imperfect bloomers.

Some growers make the mistake, even in large fields, of not planting enough of the perfect blooming varieties. Some seasons one row of a perfect blooming variety will furnish sufficient pollen for six or eight rows of imperfect bloomers, but it will not do so every season, and when it does not small rough berries are produced—"buttons," as they are commonly called in the field. More than one variety should be planted in the field to furnish the pollen, and these varieties should not bloom at the same time. If one variety should be short of blooms the other or others will furnish the supply. When varieties are planted as fertilizers they should be of a kind that produce berries of about the same size as do the imperfect blooming varieties, for convenience in picking. This saves time in the packing shed, and there is less dissatisfaction among the pickers. The list of perfect blooming sorts that are safe to plant consists of a number of good producers.

Cultivation. This is one of the important items in successful strawberry culture. The plants, for their best development, need plenty of moisture and a good supply of plant food. They may be assisted greatly in obtaining both of these by the liberal use of the cultivator.

Cultivation helps to hold the moisture in the soil and the moisture aids in making the plant food in the soil available for the use of the plant. The loose surface soil produced by constant cultivation acts as a mulch to retain the moisture and to produce the mulch cultivation should be frequent and after every rain. A rain packs the soil at the surface and pores, through which the moisture escapes, are formed. Cultivation breaks up the pores and prevents evaporation. Strawberry fields should be cultivated throughout the entire season. Cultivation should begin as soon as the plants are set. As mentioned under the preparation of the soil, deep plowing puts the soil in suitable condition to retain a large part of the early rains. The last two seasons have shown the growers that continuous cultivation will pay. In the fields cultivated thoroughly this year and last, the water supply has been sufficient to give a good plant growth, while on those not cultivated the dry weather has done great damage. The men making the greatest success in strawberry growing are those giving the best cultivation.



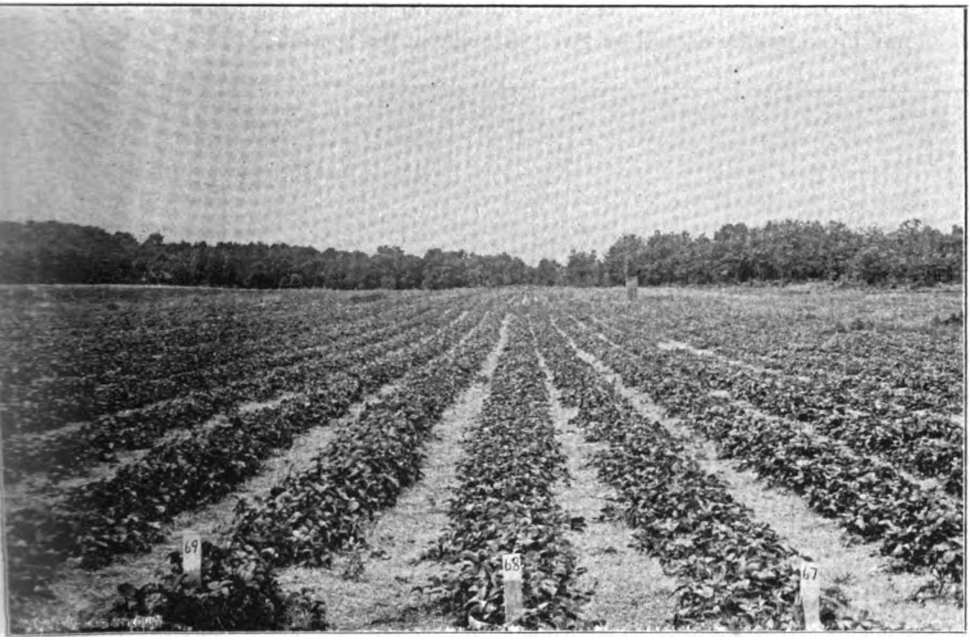
No. II.

A field at Fort Smith on Mr. Geo. H. Coleman's fruit farm. It is given here to show the results of intensive culture. The plants were set during early spring and made this growth before September 1.

The matted row system of growing plants is most generally adopted in the State. Some growers grow them in the narrow matted row or hedge row, but very few practice hill culture. By the matted row system more berries are produced on an acre than by hill culture, but the latter method gives larger and finer berries. For a fancy trade hill culture will give better results.

Cut No. 3 shows the matted row system of growing strawberries. The photograph from which this cut was made was taken in Mr. D. McNallie's field at Sarcoxie, Mo. The stakes shown at the end of the rows are used by him in marking the rows; this enables the pickers to find their rows when returning from the packing shed. The plants in these matted rows cover about 18 inches in width. This field was mulched with prairie hay, and the photograph taken during the berry season.

The ordinary matted rows are formed by allowing the cultivators to pull the runners between the hills and thus fill up that space. The cultivators are run a little farther from the rows at each plowing until the rows are from 14 to 18 inches wide. After that width is obtained the runners should be kept cut off until the end of the season. This can be done by attaching a rolling cutter to the cultivator, and cutting off the runners at the desired distance, or by the use of the hoe.



No. III.
Matted row system; field is mulched with prairie hay. The photograph was taken during berry season.

* As soon as the plants are set, commence cultivating, cultivate as close to your plants as you can get without disturbing them; you should be able to cultivate near enough so that there will not be space to exceed 3 inches wide left between the hills. Do everything possible with your cultivator as it is much cheaper and easier than with a hoe. Cultivate often, three times a week, if necessary, to get your ground in the condition you want it, and continue cultivating until the ground freezes; then, if your ground is not just in the condition you want it, wait until it thaws out, and then fix it to suit. Never stop cultivating because there are no weeds. While you will have to hoe some the amount will be governed to a great extent by how you manage your cultivators. Your field must be kept perfectly clean, and what you cannot do by cultivating must be done with a hoe and by hand. There is nothing that responds so liberally for the labor intelligently expended as the strawberry.

Renewing Old Beds. The first thing usually done when renewing old beds, where the field is burnt over, is to mow the entire field close to the ground as soon as the fruit is taken off; then, when dry, it is burnt over. Burning over old beds is practiced in some sections, but has not been done extensively in this State. It is usually more necessary in fields, where mulching is done, and it is valuable in destroying weeds, leaf rust, and insects, and leaves the field in much better condition for cultivating.

The turning plow is used to narrow down the row to about 6 inches. These rows are immediately harrowed both ways, and harrowed sufficiently to thin the plants to something near the desired stand. With a hoe they can be cut to a stand. The field is then cultivated the same as a new field, and clean culture should be given throughout the season.

---

*D. McNallie, in Strawberry Culturist, November, 1897.

No. IV.
The same field and rows that are shown in cut No. 3 after the field was renewed.

Cut No. 4 shows the same field and same rows that are shown in cut No. 3. The photograph was taken in July after the field had been renewed.

Implements: Regarding the implements to use there are many. The opinions of the different growers differ widely on this point. There are several weeders manufactured that do good work when used immediately after setting the plants. The grass and weeds can be kept down with these implements, and the surface is sufficiently stirred to check evaporation. The advantage in using them is that two rows can be cultivated by a man and a horse at once, and a number of acres can be gone over in a day. The fine tooth cultivators are good implements to use later to give shallow cultivation and to stir the soil. They are used exclusively in some fields. The ordinary two-horse cultivators are used extensively and are good implements for cultivating during the early season. They can be used then to advantage, but should not be used for summer and early fall work, as there is danger of cultivating too deep. Deep cultivation should be avoided during the summer. Shallow cultivation leaving a thin mulch of mellow earth on the surface is what is desired. The spring tooth cultivators shown in cut No. 4 do good work. They may be either riding or walking, but it is probable that better work can be done with the walking cultivator.

Mr. P. D. Scott, of Van Buren, in response to a request from the Station for a statement of his method of strawberry culture kindly furnished the following:

My experience in growing strawberries in this section has been as follows: I selected a good piece of upland, sandy loam soil, with red clay subsoil, and on a southeastern slope, it being the best. If you have new land all the better. In fact, most of my experience has been on land where the timber was cut off and the land immediately broken, harrowed, etc., and put in strawberries. I break my land in the fall with a two-horse steel plow, then harrow thoroughly and let stand until February. Then re-break and harrow as before. Then take a one-horse plow and throw up a ridge running four times to the row. Take a heavy drag or log and run over the ridge. This brings it down again so it is not to exceed 2 inches in height and pulverizes the clods that may remain. Make the rows 3½ feet apart, then take a small calf-tongue and open the bed 2 or 3 inches deep. You are now ready to set your plants. I cultivate altogether in drills. I set the plants 2 feet apart in the drill, have one man to drop the plants and three to follow, take the plants, spread the roots fan shape, put in the opening and press the dirt firmly around them. Then in a day or two take a Planet Jr. or other small plow and run around them. Cultivate with small plows after each rain, and once a week if it is a very dry season. Keep the grass and weeds out of the drill with a hoe, hoe early and often and plow oftener. When you can't think of anything else to do plow some more. Continue the cultivation until the 1st of October, plowing at least once a month. We never use mulch as this makes the berries later, and the growth here is sufficient to protect the berries from sand and dirt.

"*To Renew an Old Bed.* Immediately after the picking of the crop, as the pickers go out on one side of the patch I bring in the plows on the other. Take a one-horse turning plow, and bar off the bed down to 6 or 8 inches, then take the hoe hands and cut them out to one plant in a place about 12 or 14 inches apart. Cultivate the same as if it were a new setting. In a few days you will not be able to tell the old ones from the new, and they will produce as well and at least five days earlier than your new ones. Never let the plants grow wider in the drill than 18 to 24 inches. They will not produce half as many in a full matted row, nor will they be as large as with the half matted or hedge row.

My motto is, "*cultivate*, CULTIVATE, CULTIVATE!"

Mulching Strawberry Beds. There is considerable diversity of opinion regarding mulching in the State. It is not practiced extensively in any of the strawberry sections of the State that I am acquainted with.

Here at the Experiment Station we have had good success from mulching, and are led to believe it would pay as a general thing. There are exceptional cases, however, especially where extreme earliness is an important item, but here the time of ripening has only been retarded a few days.

Retarding the time of ripening by mulching may be of some value in holding back the blossoming period, but as a rule the delay is not of enough importance to take into account. It is earliness that is sought for in this State; and the mulching should not be so heavy as to retard the blooming period. Mulching lessens the heaving of the soil, and is of value in the northern part of the State for that purpose.

Mulching is also of great advantage in holding the moisture in the soil during fruiting time. It prolongs the season and enables the plants to ripen a heavier crop than they otherwise would. The yield has been increased here at the Station by the use of mulching, fully one-third.

To ascertain the effects of mulching we mulched a portion of each row of about fifty varieties, and left an equal portion unmulched. The same varieties gave a larger yield on the mulched portion than on the unmulched, with every variety tested.

The mulch held the moisture in the soil, and it was in good condition during the entire picking season, while on the unmulched portion the soil was dry during most of the picking season.

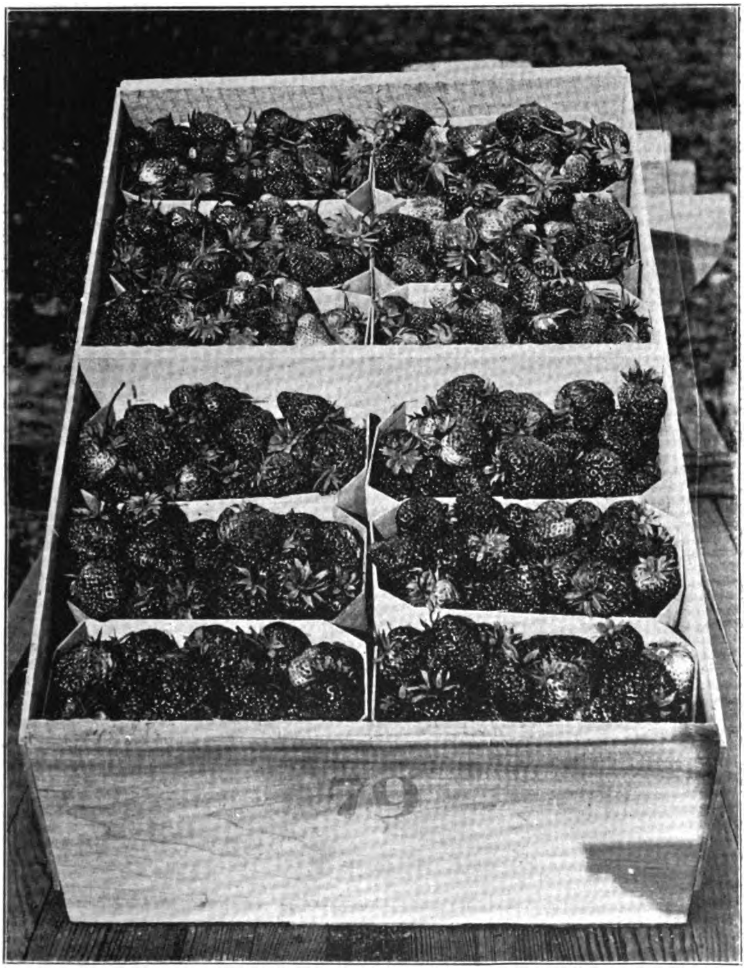
Berries are much cleaner where mulched, and the grade is much better. The experiments here show that mulching will pay better for some varieties than others. The large berries and those ripening medium to late will be most benefited by mulching.

The materials commonly used here are straw, hay, and south of here. cotton seed hulls. Forest leaves are used to some extent, but they are difficult to keep in place. Prairie hay is better than straw where it can be obtained at a fair price, as it does not carry any objectionable seed with it. Pine needles are used in the pine woods sections and make a good mulch.

Growing Material for a Mulch in a Strawberry Field. The question is often asked, What material would give best results to grow in the berry field for a mulch? There seems to be no material that is suitable. Any material grown in the strawberry field for this purpose would be injurious to the strawberry plants. The growth would necessarily take place during the summer months, and at that season the strawberry plants need all the moisture and plant food that the soil contains. If it is necessary to grow a mulch on the farm, it is better to grow it on an adjoining field and put it on the berry field during the winter. The practice of stopping cultivation during the early part of the season and allowing the weeds and grass to grow for a mulch is bad policy. The amount of plant food and moisture wasted by this method would buy the mulch and leave a surplus.

Crates. Crates used in this State are the 24-box crates. One of which is shown in the cut No. 5. Crate material comes knock-down, and is put up near the berry fields. The top is composed of two pieces which are nailed in the packing shed, after the crates are filled, unless the berries are to be inspected before being put into the car. In that case the tops are hinged on the crates with strap-iron, and slats are nailed across to hold the top together. These crates were used at Springdale this year, where all the berries were inspected before they were put into the cars.

The hinge used by the Springdale association on their crates has much to recommend it, aside from allowing the inspection of the berries before being placed in the car. It allows thorough inspection of the berries without the usual tearing off of the tops of the crates. When the berries arrive in the markets the nails may be drawn and the tops remain solid, leaving the crates in good shape, and they present a good appearance even after the berries are examined by several buyers. Under the other plan the tops are torn off and a very dilapidated appearance is presented. The hinge costs but little extra, and will probably be paid for many times in the extra price paid for the berries.



No. V.

The crate commonly used in this section. It is called the Leslee crate, 24 quarts, wine measure. One-half of the crate is filled with Bubach and the other half with Haverland berries.

Organization. Thorough organization by strawberry growers has proven of great value in most cases. It has enabled them to secure better transportation, better service from commission men, and to reach better markets. By organizing into associations, and all shipping together, they are enabled to ship in car lots.

The associations generally have a manager who keeps posted on the markets, and attends to all the shipping for the association. Where the associations are large a committee of three members is selected by the associations to attend to the business, and they direct all shipments. The returns are usually made to the individual shippers. The association at Springdale employs an inspector, and all berries shipped by the association are inspected before they are put into the cars. The inspector stamps the grade on each crate, as he is required to inspect each crate as to the quality of the fruit, and see that all boxes are well filled. Under this system those producing good berries get a better price in the markets for them than those producing an inferior grade. Where this grading is not done by the association it too often happens that the good berries in a car sell for less because of the poorer grade. Inspection has much to recommend it, and it has given good satisfaction.

The marketing is as important as the growing of a crop of strawberries; much depends on the appearance, size and quality of the fruit when put upon the market. None but good fruit should be shipped, no over ripe nor under ripe berries should be put in the boxes by the pickers; all bruised or faulty berries should be discarded. The boxes should be well filled as the berries settle considerably before reaching their destination.

The grower's name and address is usually stamped on every crate as well as the name of the variety and grade of the berries. The grower's brand on the crate should be a guarantee that the berries are as represented.

LIBRARY
UNIVERSITY
OF
CALIFORNIA

Agricultural Experiment Station

FAYETTEVILLE, ARKANSAS

ELEVENTH ANNUAL REPORT

1898

Agricultural Experiment Station

FAYETTEVILLE, ARKANSAS

ELEVENTH ANNUAL REPORT

1898

ARKANSAS EXPERIMENT STATION,
FAYETTEVILLE, ARK., December 19, 1898.

To His Excellency, DAN W. JONES,

Governor of Arkansas:

SIR—

I have the honor to transmit to you herewith the Eleventh Annual Report of the Arkansas Agricultural Experiment Station.

Most respectfully,

R. L. BENNETT,

Director.

CONTENTS.

Page.

LETTER OF TRANSMITTAL 2

BOARD OF TRUSTEES 4

STATION STAFF 4

FINANCIAL REPORT 5

REPORT OF DIRECTOR 6

ARKANSAS SEEDLING APPLES 3

IRISH POTATO EXPERIMENTS 21

METHODS OF COMBATING COMMUNICABLE DISEASES OF FARM ANIMALS 35

FEEDING VALUE TO STEERS OF COTTON SEED PRODUCTS—EFFECT OF TEMPERATURE 47

INVESTIGATIONS IN THE CHEMISTRY OF WHEAT 53

FATTENING VALUE OF CERTAIN FOODS FOR PIGS 83

ORCHARD CULTIVATION 87

Agricultural Experiment Station.

BOARD OF TRUSTEES.

His Excellency, DAN W. JONES, *President*.

HON. W. H. LANGFORD.
HON. C. C. HAMBY.
HON. V. Y. COOK.
HON. W. N. YATES.
HON. J. B. MCDONOUGH.
HON. T. A. FUTRALL.

BOARD OF CONTROL.

HON. T. A. FUTRALL. HON. W. H. LANGFORD. HON. V. Y. COOK.
DR. J. L. BUCHANAN. R. L. BENNETT.

STATION STAFF.

R. L. BENNETT	DIRECTOR.
GEO. L. TELLER	Chemist.
R. R. DINWIDDIE	Pathologist and Bacteriologist.
J. T. STINSON	Horticulturist.
C. L. NEWMAN	Agriculturist.
GEO. B. IRBY	Assistant in Feeding Experiments.
J. F. MOORE	Assistant Chemist.

Correspondents should notify the Director of any change of Post Office Address, error in Address, or failure or delay in receiving Bulletins.

R. L. BENNETT, Director,
Fayetteville, Ark.

FINANCIAL REPORT

Agricultural Experiment Station.

In Account with the United States Appropriation.

1898. **DEBTOR.**

To Receipts from the Treasurer of the United States as per Appropriation for the year ending June 30, 1898	$15,000 00
	$15,000 00

CREDIT.

By Salaries	$ 9,899 78
Labor	1,166 80
Publications	643 98
Postage and Stationery	187 56
Freight and Express	239 26
Heat, Light and Water	56 05
Chemical Supplies	226 54
Seeds, Plants and Sundry Supplies	448 55
Fertilizers	8 34
Feeding Stuffs	216 71
Library	175 58
Tools, Implements and Machinery	470 66
Furniture and Fixtures	109 51
Scientific Apparatus	163 29
Live Stock	393 85
Traveling Expenses	315 75
Contingent Expenses	17 50
Building and Repairs	260 29
	$15,000 00

The foregoing Statement is copied from the Experiment Station books, which have been examined and approved by the Auditing Committee of the Board of Trustees.

R. L. Bennett,
Director.

REPORT OF DIRECTOR.

Two Bulletins have been published this year on experiments in the development of the cheapest and best methods of producing pork and beef as money crops for the cotton farmer and the improvement of worn cotton soil.

Bulletin No. 52—Is on the feeding value to steers of cotton seed, ground cotton seed, cotton meal and hulls.—Effect of temperature.

Bulletin No. 54—Some experiments on the fattening value of certain foods gathered by pigs.

In the chemical investigations of wheat the work of the year is published and issued in Bulletin No. 53—A report of progress of investigations in the chemistry of wheat.

In horticultural experimentation two Bulletins have been issued.

Bulletin No. 49—Preliminary report on Arkansas seedling apples.

Bulletin No. 55—Orchard cultivation.

Investigations in Bacteriological and Pathological division have been continued on tuberculosis of animals and its relation to human tuberculosis.

Bulletin No. 51—Methods of combating communicable diseases of farm animals.

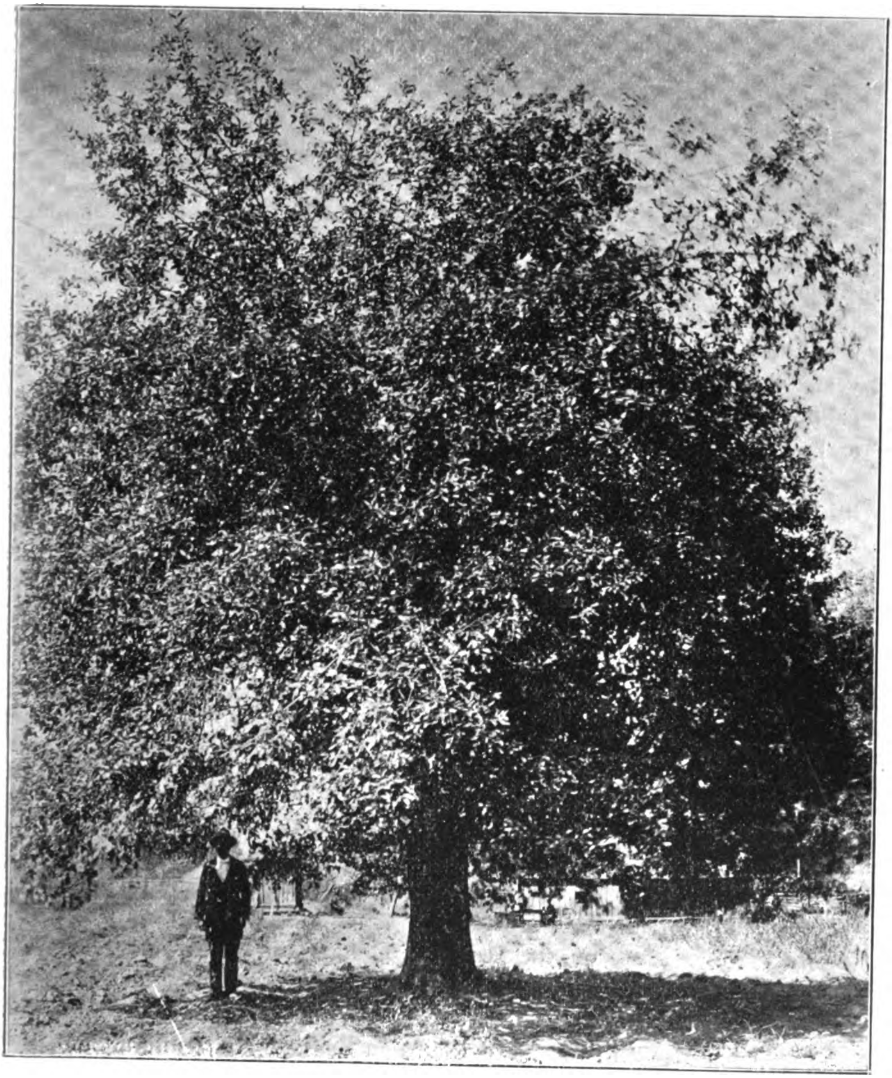
Experimental work has been begun on the adaptation and selection of legumes for feeding and fertilizing. The work is intended to comprise a test of all promising legumes.

Bulletin No. 50—Irish potato experiments.

The full text of each of these seven Bulletins is to be found in succeeding pages. See contents.

The Station is making a special effort to aid the cotton growers, who are 80 per cent of all farmers in the State, in the production of another money crop in connection with cotton. The low price of the present crop makes the reduction of the cotton acreage and the growing of another money crop on the surplus acreage an absolute necessity. Pork and beef for many reasons are the most profitable and best adapted of all crops for the majority of cotton farmers to grow as a money crop with cotton. Experiments were begun in 1894 to ascertain and develop the cheapest and best methods of producing pork and beef and in connection therewith the improvement of worn cotton soil. Experiments on those subjects will be continued as the results obtained thus far and their reception by farmers in the five Bulletins that have been published on the work fully warrant continuance.

R. L. Bennett,
Director.



ORIGINAL MAMMOTH BLACK TWIG TREE.

PRELIMINARY REPORT ON ARKANSAS SEEDLING APPLES.

BY J. T. STINSON.

In 1893 an investigation was begun of varieties of apples claimed to be Arkansas seedlings, and at the Arkansas exhibit at the World's Fair an opportunity was afforded to study over sixty varieties that were classed by the judges as unknown varieties. The writer made at that exhibit a description of each of these varieties and ascertained the locality from which they came. This investigation has since been continued in orchards throughout northwest Arkansas. Some of the apples first brought to notice, and those that attracted considerable attention at the World's Fair, are varieties that have been extensively grown in several localities for a number of years, but many of them are unknown outside of these places. The localities where these varieties were said to have originated have been visited, and all possible information relating to them was collected, and after further work, a complete report on the subject will be issued. The object in publishing this preliminary report in advance is to bring to the attention of the fruit growers of this State some facts regarding a few of the most important of the new varieties, in order that those desiring to purchase trees may have a guide as to their identity, etc.; also, to encourage coöperation of fruit growers in the further study of the subject. Another reason for this preliminary report is, that enterprising nursery firms located in other States have secured stock of some of these varieties and are selling them under different names than those by which they are known in the State. The fruit growers of the State do not approve of the renaming of varieties of apples that have been known in this State for years. The State Horticultural Society at its last meeting passed the following resolution, which explains itself:

Resolution. "Whereas, the renaming of Arkansas seedling apples by parties outside of the State confuses the nomenclature and does not give proper credit to the local introducers of the same, and

"Whereas, foreign nurserymen are selling these varieties under new names at extortionate rates,

"Therefore be it resolved by the Arkansas State Horticultural Society, now in session at its fifth annual meeting at Bentonville, Ark., that the renaming of Arkansas seedling apples be condemned.

"Be it further resolved, that the local names by which these apples are known in the State be adopted by this society."

This State is noted for the fine seedling apples it produces, and new ones are being brought into notice every year. The past season several new varieties that are exceedingly promising have been shown at the local fairs for the first time. There are a number of worthy new apples that are not mentioned here, because we have never been able to ascertain definitely their histories. Most of the apples mentioned are of especial value in the localities where they originated, and a few of them have been grown in several other localities in this part of the State, and many of them will do well in other sections. It is believed that they will do well considerably north of this. It is probable that the varieties that are fall apples in this section would be winter apples when fruited further north, and those that are winter apples here might be extra good keepers there.

The names by which these varieties are known in this State are retained where it is practical to do so. When changes had to be made with those having the same or similar names as other varieties, we endeavored to conform to the rules of the American Pomological Society. Many of the names given as synonyms are the local names of the varieties. Rules 3 and 4 of the American Pomological Society are as follows:

Rule 3. The name of a fruit should, preferably, express as far as practicable by a single word, a characteristic of the variety, the name of the originator, or the place of its origin. Under no ordinary circumstances should more than a single word be employed.

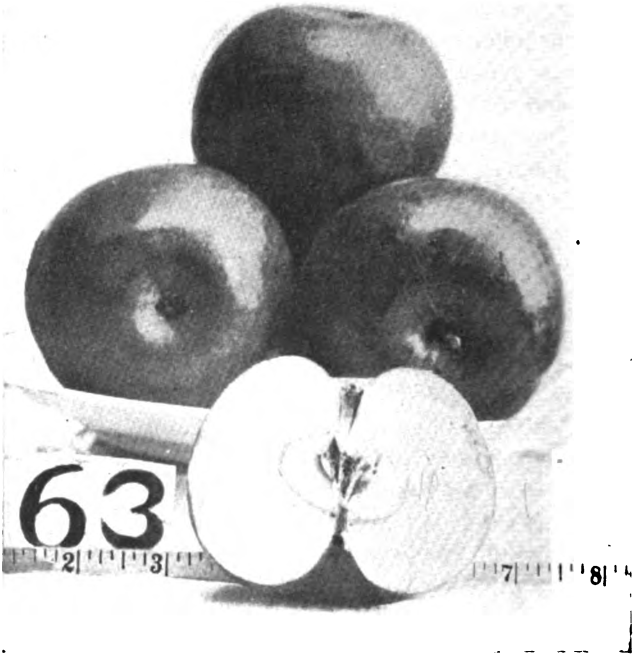
Rule 4. Should the question of priority arise between names for the same variety of fruit, other circumstances being equal, the name first publicly bestowed will be given precedence.

Arkansaw (Mammoth Black Twig). This variety has attained considerable popularity in the Southwest during recent years. It is grown to some extent in Iowa and Illinois, and is planted quite extensively in some sections of Missouri, and is also being planted extensively in this State. Reports of it, where it has fruited, are favorable. The apple is larger than the Winesap, but is not of as fine flesh; quality is very good. As a keeper it is good, keeping until late in the winter.

This variety is probably a seedling of Winesap, as the tree and fruit both indicate as much, but it does not come into bearing as early as Winesap.

The history of this variety was obtained by the writer from Robert Crawford, near Rhea's Mill, Ark. The original tree stands on the farm formerly owned by his brother, Wm. Crawford Robert Crawford was unable to remember all the points connected with the early history of the tree, but he said that the variety was a seedling and it had always been called a seedling by his brother and those interested in propagating it. Mr. Miller, who now lives on the Wm. Crawford farm, where the original tree stands, informed me that Wm. Crawford's son told him that the seed from which the tree grew was planted in 1833 or 1834. Geo. W. Collins, near Rhea's

Mill, was working with Ben Holt, and assisted him in 1868 in cutting scions from the tree for grafting in Mr. Holt's nursery. The trees of this variety were soon in demand, and it was grafted extensively by them. The tree is said to be about 67 years old and is so considered by those living in the neighborhood. From appearances I would judge it to be at least that old. The cut exhibited on first page is from a photograph taken last fall, when the tree had a fair crop of apples. The largest trunk measure of the tree is 7 feet 4 inches in circumference, and at the smallest point below the limbs 6 feet, 7 inches. In 1854 about one-half of the tree was broken off, but it has since recovered and a new top has been formed.



ARKANSAW.

The name Mammoth Black Twig was given the variety on account of the size of the fruit. The Winesap was known at that time in this section as Black Twig, and is so called by many at the present time. This apple was often called the Big Winesap. The name Arkansaw was given the variety at the New Orleans Exposition by Colonel E. E. Babcock, then of this

State. It is commonly known in this section, and to the trade, as Mammoth Black Twig.

As the American Pomological Society, in its recent catalogue of fruits, gives the name Mammoth Black Twig as a synonym, we give it also as a synonym. The name Mammoth Black Twig is confusing and it would probably be best to call it Arkansaw. There is but little doubt that this variety is a seedling originating in this State, notwithstanding the variety is confused to some extent with the apple of Tennessee origin called the Paragon, which is also a seedling of the Winesap. There has been much written of these two varieties in the horticultural journals, especially in *American Gardening*, and the reader is referred to *American Gardening*, 1895, page 419; 1896, pages 48, 65, 146, 153, 210 and 306. Also, to the Bulletin of the Tennessee Agricultural Experiment Station, on apples of Tennessee origin.

I am of the opinion that the Arkansaw and the Paragon are two distinct apples. I have examined specimens of the Paragon from Tennessee that resembled the Arkansaw very closely; also examined other specimens that were said to be the true Paragon, yet they were of a distinct variety. Professor Watts gives quite an extensive history of the Paragon in Bulletin No. 1, Vol. 9, Tennessee Experiment Station, and says, in substance, that the fact has been established that there are two Paragon seedling apples, one in Tennessee and the other in Arkansas.

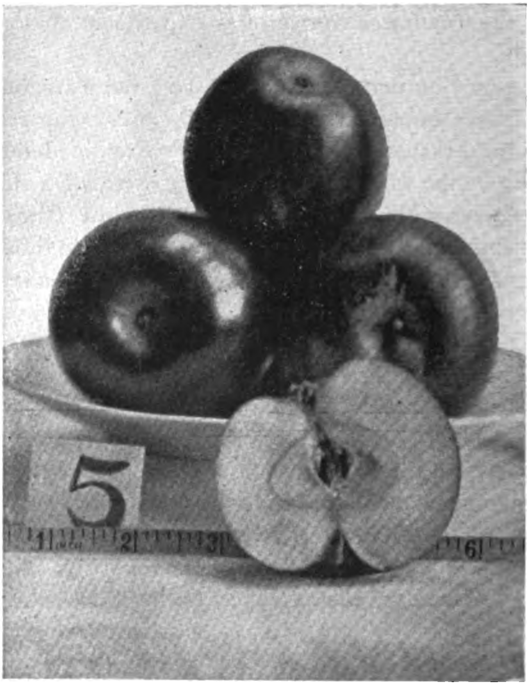
**Paragon* (The late W. L. Moores, M. D., Cyruston, Tenn.). Having on request sent both the Gilbert and the Paragon to the Department of Agriculture, Dr. Moores wrote: "Both originated in this neighborhood; both original trees are standing (December, 1895) and bore fruit this season. I named both apples and introduced them to public notice about eight years ago. The Paragon has obtained wonderful popularity, yet I believe it is an inferior apple to the Gilbert, its twin brother. Both apples are apparently a cross of Black Twig (Winesap) and Limbertwig, and are so much alike in appearance as to require an expert to distinguish them." Roundish conical; large, smooth, yellow, washed with red, having a few indistinct stripes; dots of medium size, yellow; cavity large, regular, deep, flaring, russet; stem short, slender; basin medium in size and depth, abrupt, furrowed; calyx segments small, converging or slightly reflexed; eye small, nearly closed; skin thick, tough; core medium, conical, clasping, partially open; seed numerous, of medium size, plump, brown; flesh yellow, moderately fine grained, breaking, juicy; subacid; very good. Season, winter.

Arkansas Black. A variety that has attracted considerable attention at fruit shows on account of its high color. It is a very dark red, almost a black, some specimens being partially black. The variety originated in Benton County, Ark., and Mr. Alvin Dickson informs me that the variety originated in the orchard of Mr. Brathwait, one and one-half miles northwest of Bentonville, and that it first fruited about twenty-five years ago. It has proven to be rather a shy bearer in this section and the fruit is subject to apple scab. From the experience with this variety up to the present time, growers would not be justified in planting it extensively. It may do better in other sections and should be tested before large plantings are made.

---

*Report of Pomologist U. S. Department of Agriculture for 1895.

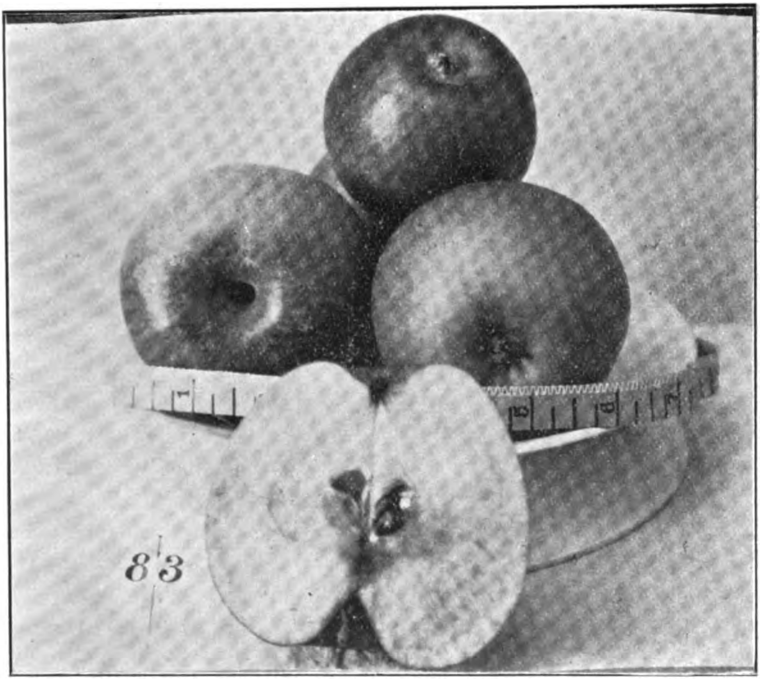
The fruit is of medium size as a rule, but some years it grows larger; form round; cavity regular and small to medium; basin shallow; surface smooth; color dark red to black; flesh yellow, fine grained, juicy; quality very good; season, winter; tree an upright grower, wood dark.



ASHTON.

Arkansas Belle. This is probably a seedling of Ben Davis, but it so closely resembles Gano and Ragan's Red that it ordinarily would be considered identical with them, and as Gano is well known, a description of the Arkansas Belle is not given.

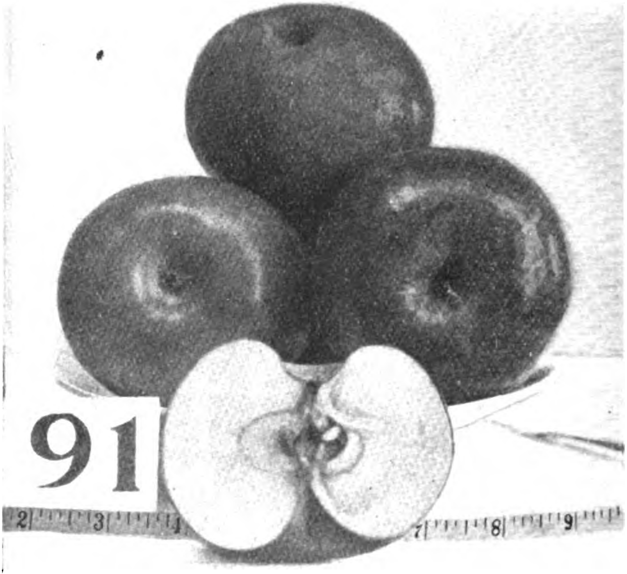
Ashton. A small to medium red apple of value, where a sweet apple is desired. The original tree stands in Mr. Marshall's orchard a few miles east of Cincinnati. It is very productive, bearing heavy crops annually. The tree resembles the Winesap somewhat, but it branches more freely, and the branches are more slender; is a good grower. Form roundish, uneven; stem medium and long; cavity medium, usually marked with a lip, russeted; color dark red on yellow ground, very highly colored, sometimes nearly black; skin thick, surface covered with minute light dots; core small to medium; flesh fine grained, white to slightly yellow, tender; flavor sweet, good to very good. Season, early winter.



BEACH.

Beach (Lady Pippin). A variety grown to considerable extent in Benton and Washington counties, and of considerable merit, as it is a sure bearer and the apples keep well. Specimens of this variety were compared with specimens of Richardson Red (Apple of Commerce) during the past season, and were pronounced to be identical. Tree a good grower, both in the nursery and in the orchard. I have been unable to secure the complete history of the tree. Mr. H. Highfill tells me that he secured trees of this variety from a man by the name of Oliver Young, some twenty-eight years ago. It is hoped in the complete report to be made on these apples that we may be able to give its complete history.

Fruit medium to large size; form roundish. inclined to ovate, irregular in shape; cavity medium, abrupt, russeted; stem medium; basin shallow, and distinctly ribbed, some specimens deeply corrugated in the basin; color, greenish yellow ground, splashed and striped with a rather light red, sometimes highly colored, the whole surface being covered with a dark red, small, white dots thinly scattered over the surface; flesh yellowish, tough, rather coarse, juicy; flavor, subacid, good. Season, late winter.



COLLINS.

Collins (Collins's Red, Champion Red, Champion, Coss's Champion). The original tree came up about 33 years ago, on the old Merriman farm one mile south of Mr. Geo. Collins's nursery. In making a collection of seedling apples in 1885, Mr. Collins took apples from this tree, and noticed for the first time that they were a superior apple. In 1893, the variety was named Collins in honor of the introducer by Hon. W. G. Vincenheller, while making a collection for the Arkansas exhibit at the

World's Fair. Mr. Collins began grafting from this variety in 1886, and it was quite extensively planted in several orchards in this section, some of which are now in bearing. As a Mr. Coss was living on the Merriman farm when the first grafts were made, the apple was called by some, Coss's Champion, by others, Coss's Seedling. It is also locally known as Collins's Red and Champion Red. The name Collins is without question the proper name for the variety, and recently in conversation with Mr. Collins, he expressed a desire that the name Collins be allowed to stand for the variety.

This is a valuable apple owing to its productiveness and keeping qualities. It is very productive, tree healthy and a good grower in the nursery.

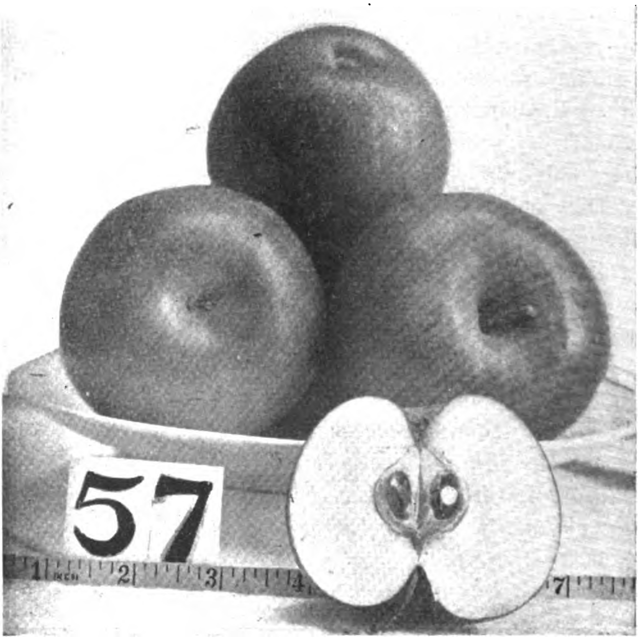
Form roundish, oblate, slightly ribbed, large; stem long to medium: cavity deep, usually smooth and green, sometimes slightly russeted; basin large, regular, rather deep and abrupt, slightly corrugated; color, yellow greenish ground, shaded and striped with red; surface covered with light dots; flesh solid, color, light yellowish, moderately coarse, juicy and good. Season, winter.

Etris. This apple is claimed to be a seedling from Benton County. Mr. Alvin Dickson, of Bentonville, writes me that "The Etris apple first fruited about fifteen years ago in the orchard of A. K. Etris, 5 miles east of Bentonville. The tree came from the nursery of John Brathwait, who knew nothing about the variety when the fruit was shown to him. Another party got four trees from him at the same time that Mr. Etris got the one tree. We have propagated from the Etris tree and we retain the name Etris for the apple."

This variety resembles Gano very closely. As far as I am able to judge, there is practically no difference. It also resembles Ragan's Red and Arkansas Belle, both of this county.

Evans (Walker's Sweet). This is a sweet apple of considerable merit. It is a good keeper, keeping until spring without any trouble. Mr. C. Walker, of Lowell, furnished specimens of this variety from the original tree, which is now standing near Lowell and bearing good crops of fruit. It is a good sized apple, form oblate conical; cavity medium, irregular, deep; stem medium to long, stout; basin large, regular, slightly furrowed, slope abrupt; surface smooth; skin yellow, splashed and striped with a very thin covering of red, giving the apple a light color, gray dots scattered over the surface; flesh yellowish, firm, rather tough; it is called a sweet apple, but it is pronounced to be mild subacid by some. Season, late winter.

Givens. Is a variety that, owing to its keeping properties and good quality, is of considerable merit. It originated on the farm of Mr. Givens in Benton County, and has been propagated and sold quite extensively by Mr. Highfill, of Springtown. It is a productive tree, hardy, and a good grower. Fruit large, round, oblate; cavity deep, slope broad, russeted: stem long, slender; basin medium, broad, slightly ribbed, calyx small: surface somewhat indistinctly ribbed; shape of apple irregular, one side usually larger than the other; color, bright yellow ground, covered and indistinctly striped with red, small dots scattered over the surface; light bloom; flesh white, slightly tinged with yellow, texture firm; quality very good; mild subacid. Season, late winter.

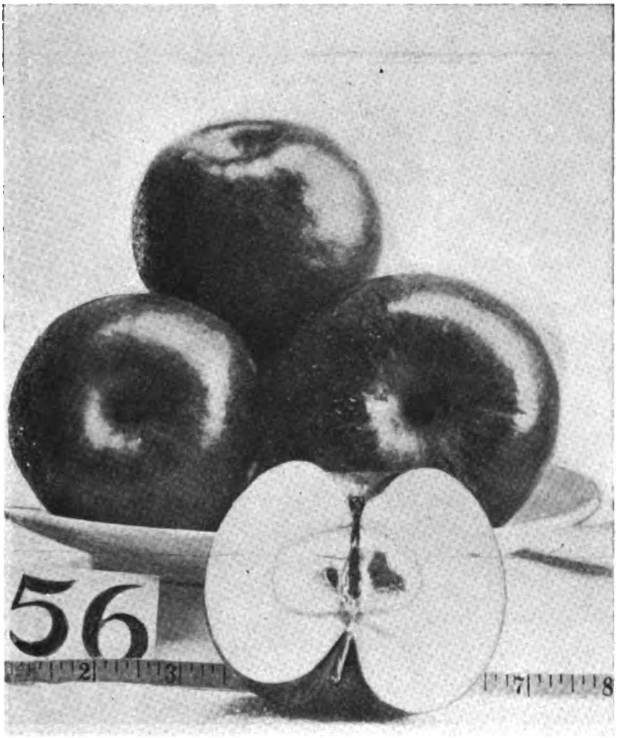


EVANS.

Heiges (Red Limbertwig). A variety of considerable merit; tree vigorous and productive, somewhat on the Limbertwig order.

Form roundish, slightly conical; stem rather small, medium to long; size medium to large; cavity medium, sometimes russeted; basin shallow and small; color, yellow ground, covered with red, sometimes highly colored; surface covered with minute dots which are very thick near the calyx; flesh fine grained, yellow, tender; mild subacid and very good to best. Season, early winter. It is grown to considerable extent in this State.

Highfill. A seedling of Ben Davis. It was originated by Mr. H. Highfill near Springtown. He says that the seed was planted about twenty-two years ago. The tree resembles Ben Davis, is an early bearer and very productive.

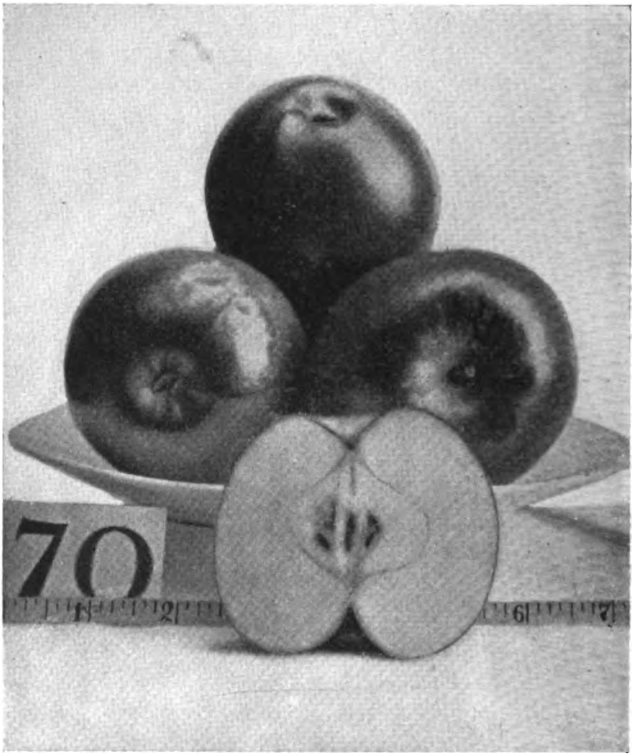


GIVENS.

Form roundish conical; stem medium, cavity deep, acuminate, lipped and russeted; basin deep, narrow, abrupt; color yellow ground splashed and covered with red, highly colored; heavy bloom, flesh white to yellow, tender; flavor mild subacid, good. Season, winter.

This is a good market variety because of its color and productiveness. It is of enough value to be tested in the different fruit sections.

Holt's Seedling. This variety originated on the old Earl Holt farm which is situated in the western part of this county. Tree a good bearer; fruit large, oblate, conical; stem medium; cavity deep, wide, and irregular, russeted; basin deep and very narrow; color greenish yellow, splashed with a dull red and sometimes striped with a darker shade; surface covered with small russet dots; flesh greenish yellow, solid, crisp, medium to fine grained, juicy; flavor subacid; quality good. Season, winter.



HEIGES.

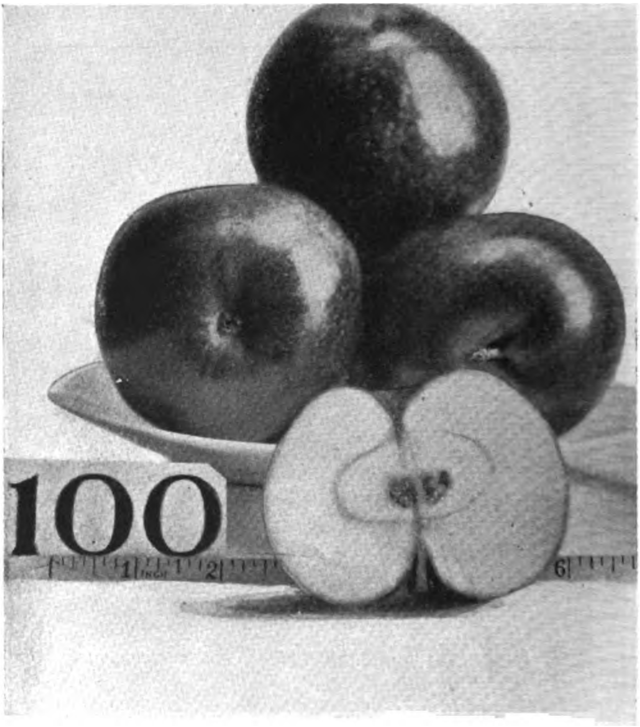
Mock (Mock's Winter). This variety received some prominence by the award of first premium, for being the best winter seedling apple exhibited at the Fort Smith fair a few years ago. It originated on the farm of Mr. James Mock, of Prairie Grove, but has not yet been propagated extensively. Form roundish; cavity medium in size and depth, with a very large lip on one side, often extending further over than the base of the apple; stem long, medium to stout; skin smooth; color greenish yellow round which is covered with a dark red, highly colored; surface covered with dots; flesh yellowish, tinged with red, fine grained, crisp and moderately juicy; flavor subacid, good. Season, winter.

Nebo. Mr. Geo. Collins, Rhea's Mill, says that the original tree of this variety came up from the root of a Jennette tree. It is of more value as a curiosity than as an apple to grow for profit. The description of the apple is from report of the Pomologist of the Department of Agriculture for the year 1895: "Elongated, conical, unequal; large; moderately smooth, having fine russet patches over much of the surface; color yellow, washed with red, indistinctly striped with crimson, and overspread with thin russet; dots conspicuous, russet; cavity medium in size and depth, irregular, gradual, lipped and russeted; basin medium in size and depth, regular, abrupt, furrowed and russeted; calyx segments very short, separated, reflexed; eye open, nearly flat; skin moderately thick, tough; core medium, conical, clasping, nearly closed; seeds few, large, short, plump, brown; flesh whitish, satiny, fine grained, tender, moderately juicy; sweet, very rich; very good to best. Season, early winter."

HIGHFILL.

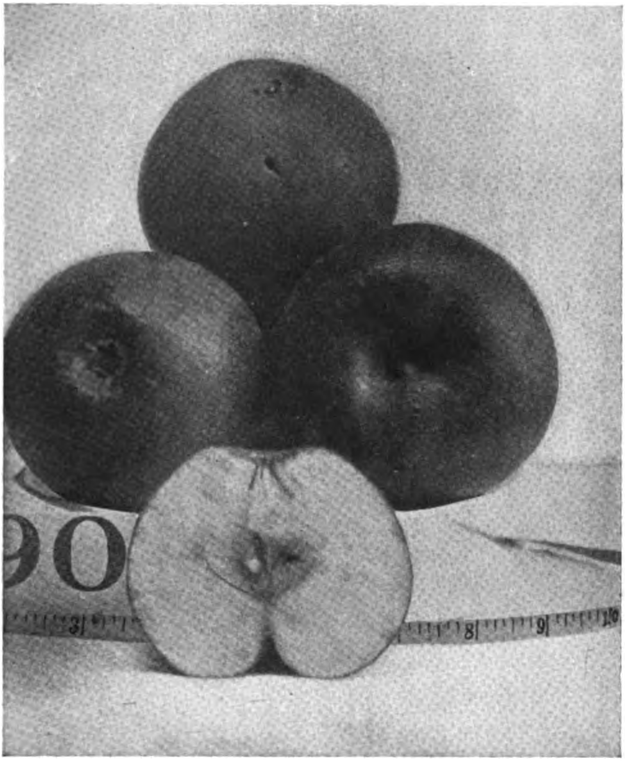
Oliver (Oliver's Red, Senator). This variety attracted considerable attention when on exhibition at the World's Fair, and later at the Atlanta Exposition. It is grown quite extensively in the western part of this county and a number of orchardists have been fruiting it for some years.

Mr. Geo. Collins, who has been propagating the apple for about twenty-five years, says that he got his first scions from trees on Mr Chas. Miller's farm and that Mr. Miller's trees came from the Holt nursery. Mr. Collins further says that there is some difference of opinion as to where Mr. Holt got the first stock, but it is claimed by many, and it is probably correct, that it came from the old Oliver farm. The apple was named Oliver's Red and has been known by that name up to the present time.



MOCK.

It is a handsome apple. Form roundish, oblate, the form varies, some specimens are nearly flat while others are but slightly flattened; size large; stem medium, short and stout; cavity regular, medium, gradual slope and green color, sometimes slightly russeted; basin wide, deep, rather indistinctly corrugated; color deep yellow ground covered with a bright red, finely colored; surface covered quite thickly with large russet dots; skin thick; flesh tinged with red, fine grained, juicy; flavor mild subacid, sprightly; quality very good. Season, late fall. It ripens soon after Jonathan, but is a much better keeper, sometimes keeping until after Christmas. It is a valuable apple for its season and is good for fancy trade. It is fairly productive.

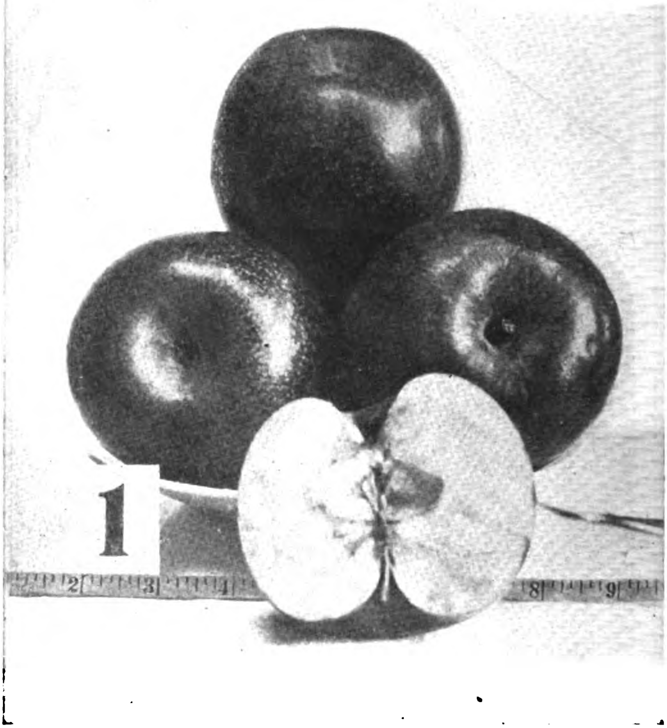


NEBO.

Ozone (Martin's Red). A colored plate of this variety may be found in the report of the Pomologist of the U. S. Department of Agriculture for 1895. The apple is known in Madison County as Martin's Red. Specimens of it were sent from Ozone, Ark., to the Department of Pomology; the name Ozone was given it. It is above a medium sized apple and of attractive appearance.

Form roundish, conical; cavity medium, deep, abrupt; some specimens russeted but most of them green; stem short and stout; basin medium in size, slightly furrowed; skin tough; color yellow, splashed with crimson and sometimes indistinctly striped with a darker shade; surface covered with conspicuous dots, sometimes part of the surface covered with russet; flesh yellowish, very tender, juicy; mild subacid, and very good to best. Season, fall and early winter.

Reagan (Black Ben Davis). This variety resembles Gano very closely, but may be a distinct seedling. I have been unable to trace the history of the variety to the original tree. For a description of it we can take the Ben Davis, with the exception that this variety is of darker color and possibly a little better flavor than the Ben Davis.

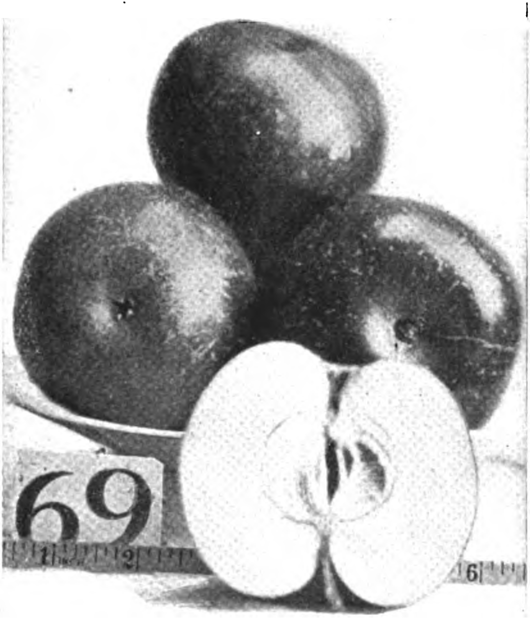


OLIVER.

We will endeavor for our complete report to secure some more information regarding these varieties which seem to be almost identical with Gano, but which are said to be seedlings of Ben Davis. Our study of the trees in the nursery would also lead us to believe that this variety and Gano are identical.

Rutherford. Specimens of this variety were obtained from Mr. Neurch, at Cove Creek, near Hot Springs. The variety originated with Dr. Rutherford, near that place. Tree slender in habit, branches long and slender; resembles a pear tree in appearance.

Fruit large, form oblong; cavity regular, large, deep and slope abrupt, russeted; stem medium, slender; basin small, shallow, abrupt and furrowed; surface smooth; color greenish yellow, with very light blush of red—it is said to be nearly covered with red when left on the tree till late in the season; surface thinly covered with small dots; flesh yellowish, fine grained; flavor mild subacid, good. Season, winter. It is a good keeper and for that reason is considered valuable in the section where it originated.



OZONE.

Tunnell. This is a seedling in the orchard of Mr. S. Tunnell, near Cincinnati, Ark. The tree is thrifty and productive. The description here given is taken from the report of the Assistant Pomologist of the Department of Agriculture for the year 1893:

"Roundish, oblate, above medium in size; surface moderately smooth, greenish yellow, striped, shaded and splashed with red and somewhat netted with russet; dots numerous, large, yellow, with brown centers; cavity large, regular, deep, with gradual slope with green markings; stem long, slender; basin large, regular, deep, abrupt, russeted; calyx segments wide, short, meeting over the eye, which is large and partially open; skin thick, tough; core small, conical, closed, clasping the eye; seed numerous, of medium size, plump, pointed, dark brown; flesh yellowish, fine grained, not very juicy; flavor sweet, aromatic, rich; quality very good. Season, autumn in Arkansas. A delicious sweet apple."

SECOND CROP POTATOES FOR SEED.

In the fall of 1893 the Station grew a lot of excellent second crop potatoes for seed, and planted them the following spring with Northern grown seed of the same varieties. The results as regard the yield and earliness of the two lots were different from what was expected, and the experiment was repeated in 1895 and again in 1896, each time with an increased number of varieties. The result of the three years' tests, singly and collectively, indicated that Northern grown seed are more desirable than the second crop seed, as they produce more, cost less, and mature earlier. This is contrary to the opinion of Southern growers expressed in the agricultural press, and the results of the 1894 and 1895 experiments were withheld for comparison with later results. The supply of second crop seed has rarely equaled the demand, and growers have had no difficulty in disposing of them at an advanced price, if not at a profit.

Both Northern grown and second crop seed of Bliss Triumph and Early Rose were planted in the spring of 1894 for the purpose of comparing their respective yields. These two varieties were then grown in the southern part of the State, and in many other sections, more extensively than all others combined, and very probably are the most popular varieties grown. The results of the 1894 tests are given below:

NORTHERN GROWN AND SECOND CROP SEED IN 1894.

Name of Variety.	Merchantable Yield per Acre in Bushels.	Total Yield per Acre in Bushels.	Yield of Culls per Acre in Bushels.	Number of Days Second Crop Seed were Later than Northern.	Number Days from Planting to Maturity.
Northern Bliss Triumph	84	96	12	....	104
Second Crop Bliss Triumph	68	83	15	2	106
Northern Early Rose	89	102	13	....	110
Second Crop Early Rose	65	91	26	5	115
Average Northern Grown	86.5	99	12.5	....	107
Average Second Crop	66.5	87	20.5	3.5	110½
Difference	20.0	12	8.0	....	3.5

The Northern grown seed not only produced an average of 20 bushels per acre more of merchantable potatoes than the second crop seed, but produced them three and one-half days earlier. Only 12.6 per cent of the total yield from the Northern grown seed were culls, while 23.5 per cent of the total yield from the second crop seed were culls.

The 1895 results, while not so marked, confirmed those of 1894. Four varieties were used in the test, and with one exception the Northern grown seed produced the greatest yield, and in two cases matured earlier than the second crop seed, averaging 2.75 days earlier. In the other two cases the dates of maturity were the same for Northern grown and second crop seed of the same varieties. 13.6 per cent of the second crop seed were culls and 9 per cent of the Northern grown seed. All of the second crop seed used in the test were grown by the Station, and only the best tubers from the best vines were used. As far as possible the Northern grown seed were cut into pieces of about the same size as the second crop, the potatoes of both lots being of as near the same size as the supply would permit. The following table gives the results of the trials of the

NORTHERN GROWN AND SECOND CROP SEED IN 1895.

Name of Variety.	Merchantable Yield per Acre in Bushels.	Total Yield per Acre in Bushels.	Yield of Culls per Acre in Bushels.	Number Days Second Crop Seed were Later than Northern.	Number of Days from Planting to Maturity.
Northern Grown Beauty of Hebron	119.00	128.00	9.00	....	121.00
Second Crop Beauty of Hebron....	98.00	121.00	23.00	7.00	128.00
Northern Grown Bliss Triumph....	93.00	102.00	9.00	....	116.00
Second Crop Bliss Triumph	88.00	96.00	8.00	....	116.00
Northern Grown Peerless	101 00	116.00	15.00	....	127 00
Second Crop Peerless......................	69.00	86.00	17.00	....	127.00
Northern Grown Early Rose..........	88.00	97.00	9.00	....	114.00
Second Crop Early Rose.................	94.00	101.00	7.00	4.00	118.00
Average Northern Grown	100.25	110.75	10.50	....	119.50
Average Second Crop......................	87.25	101.00	13.75	2.75	122.25
Difference..............................	13 00	9.75	3.25	2.75	2.75

The soil upon which this test was made was planted in cotton in 1893, producing about ⅓ of a bale, and in oats, followed by cowpeas broadcast, in 1894. The pea vines made a poor growth and were not plowed under until the soil was being prepared for the potatoes early in 1895.

In the third year's trials there were seven varieties, the second crop seed of which were grown by Mr. Jeff Welborn, with the exception of Bliss Triumph, which was grown by the Station. The Northern grown seed were procured of the Plant Seed Company and Messrs. T. W. Wood & Sons. An excessively dry and hot spring hastened the maturity and curtailed the yield of all crops in 1896. After April 13 only 1.20 inches of rain fell up to June 1, and this was so scattered and followed by such high temperature that it was of but slight benefit. The result of the 1896 test, while not so marked as those of the two previous years, is confirmatory of them in every particular of the averages, as will be seen from the table.

NORTHERN GROWN AND SECOND CROP SEED IN 1896.

Name of Variety.	Merchantable Yield per Acre in Bushels.	Total Yield per Acre in Bushels.	Yield of Culls per Acre in Bushels.	Number of Days from Planting to Maturity.	Number Days of Difference in Date of Maturity.
Northern Grown Beauty of Hebron	109.50	117.50	8.00	101.00	2.00
Second Crop Beauty of Hebron	103.50	116.25	12.75	103.00	
Northern Grown Bliss Triumph	87.50	100.75	13.25	103.00	
Second Crop Bliss Triumph	68.50	86.25	17.50	103.00	
Northern Grown Crown Jewell	120.75	133.00	12.25	101.00	
Second Crop Crown Jewell	108.25	119.50	11.25	98.00	3.00
Northern Grown Early Rose	66.75	76.50	9.75	95.00	15.00
Second Crop Early Rose	85.50	97.50	12.00	110.00	
Northern Grown Freeman	66.75	85.25	18.50	101.00	
Second Crop Freeman	40.75	60.25	19.25	101.00	
Northern Grown Puritan	116.00	125.75	9.75	98.00	5.00
Second Crop Puritan	116.00	134.00	18.00	103.00	
Northern Grown Wood's Earliest	118.75	121.25	2.50	95.00	3.00
Second Crop Wood's Earliest	108.25	114.25	6.00	98.00	
Average Northern Grown Seed	98.00	108.57	10.57	99.14	3.14
Average Second Crop Seed	90.13	104.03	13.89	102.28	
Difference	7.87	4.54	3.32	3.14	

A notable exception, as regards the yields in the 1896 tests, was in the case of Early Rose, which gave 18¾ bushels per acre more of merchantable from the second crop seed than from the Northern grown, and 21 bushels more in the total yield. The Northern seed, however, ripened fifteen days earlier than the second crop, and on May 20 gave a yield of 59.25 bushels merchantable potatoes per acre against 52.25 bushels of the second crop, leaving the advantage with the Northern seed for earliness. Another exception in favor of the second crop seed in 1896 was the ripening of Crown Jewell three days earlier than from the Northern seed of the same variety.

The average for the three years gives a profitable advantage in favor of Northern grown seed, both in yield and earliness, though no difference could be detected as regards the keeping or cooking qualities. The vines of the second crop seed plots were a little larger than the others, and the 1896 crop of Northern Rose produced vines barely more than half so large as the vines of the second crop Rose. The table gives the average of each year's average for the three years, and will doubtless interest the advocates of second crop seed for early planting to secure early crops.

SECOND CROP SEED COMPARED WITH NORTHERN GROWN SEED: AVERAGE OF 3 YEARS.

Character of Seed.	Merchantable Yield per Acre in Bush'ls.	Culls Yield per Acre in Bushels.	Total Yield per Acre in Bushels.	Number of Days from Planting to Maturity.
Northern Grown Seed	94.91	11.19	106.10	108.54
Second Crop Seed	81.29	16.04	97.34	111.67
Difference	13.62	4.85	8.76	3.13
Per cent Increase	16 75	43.34	9.00	....

The average of the results of the three years' trials give Northern seed a profitable advantage over the second crop seed in both yield and earliness, the former maturing 3.13 days earlier than the latter, and giving an increased yield of 16.75 per cent of merchantable potatoes and 9 per cent increase of total yield. On the other hand the second crop seed produced 43.34 per cent more culls than the Northern grown seed.

The Northern grown seed came up promptly and regularly, forming thick-stemmed and vigorous plants, while the second crop seed were slow and irregular in sprouting, and the vines, as a rule, were inferior in vigor and appearance. Portions of the second crop plots continued to come up for two weeks after the Northern seed were all up, but finally gave very near the same per cent of a stand. The stand was finally reduced to the same number of plants on each set of plots that the comparison might be more exact, on the basis of equal stands, but in reality the removing of plants to give the same number in each set of plots was an advantage to the second crop seed and a proportionate disadvantage to the Northern seed, inasmuch as in no case did the second crop seed give so good a stand. All plants that were destroyed to balance the stand were removed from Northern seed plots, which in some cases amounted to a little more than 20 per cent, with an average of about 9 per cent of a perfect stand.

In the experiments discussed so far, the yield referred to is the mature yield secured when the ripe potatoes were harvested.

In 1896 Northern grown and second crop seed of the seven varieties were planted in duplicate plots, four plots each of Northern grown and second crop seed, that the yield at different stages of growth might be determined. Plots were harvested May 20, June 1, June 10, and June 18, and the merchantable product sold at once in the local market at ruling prices, and the yield and value of each plot computed per acre. Each plot was of the same area and contained the same number of plants. The object of the experiment was the comparison of the yield and value of Northern grown and second crop seed for the extra early market. The treatment of all plots was identical, and the only noticeable advantage one lot had over another was the superior size of the Northern grown seed, which, however, were cut to pieces of the same size as the second crop seed. The number of eyes per piece was greater for the second crop seed than the Northern grown on account of the smaller tubers of the former. All pieces were rather small, but closely inspected to make sure that they were sound.

The detailed results, including dates of different diggings, with yield and value of each and date of maturity, appear in the subjoined table. No account of culls is here given, but only the merchantable product.

A COMPARISON OF NORTHERN GROWN AND SECOND CROP SEED POTATOES FOR EARLY MARKET.

Name of Variety.	Date Ripe.	Yield per Acre in Bushels.				Value per Acre of Merchantable Product in Local Market When Dug.			
	June	Dug May 20.	Dug June 1.	Dug June 10.	Dug June 18.	May 20. $1.20 per Bushel.	June 1. 90c per Bushel.	June 10. 75c per Bushel.	June 18. 65c per Bushel.
Northern Grown Beauty of Hebron	8	91½	104¾	109½		$109 80	$ 94 27½	$ 82 12½	
Second Crop Beauty of Hebron	8	85	100	103½		102 00	90 00	77 62½	
Northern Grown Bliss Triumph	6	68¾	79¼	87½		82 50	71 32½	65 62½	
Second Crop Bliss Triumph	8	58¼	66¾	68¾		69 90	59 07½	51 56¼	
Northern Grown Crown Jewell	6	85½	100	120¾		102 60	90 00	90 56¼	
Second Crop Crown Jewell	3	69¾	100	108¼		83 70	90 00	81 18¾	
Northern Grown Early Rose	1	59½	66¾	66¾		71 40	59 07½	50 06¼	
Second Crop Early Rose	15	52¼	79¼	85½	88¾	62 70	71 32½	64 12½	$57 68¾
Northern Grown Freeman	6	64¼	58¼	66¾		77 10	52 42½	50 06¼	
Second Crop Freeman	6	35½	37½	40¾		42 60	33 75	30 56¼	
Northern Grown Puritan	3	85	99¾	116		102 00	89 77½	87 00	
Second Crop Puritan	8	79	87½	116		94 80	78 75	87 00	
Northern Grown Wood's Earliest	1	108¼	116¾	118¾		129 90	105 07½	89 06¼	
Second Crop Wood's Earliest	3	104¼	108¼	108¼		125 10	97 42½	81 18¾	
Average Northern Grown Seed		80.39	89.35	98.00		$ 96 46	$ 80 420	$ 73 500	
Average Second Crop Seed		69.14	82.75	90.14		82 90	74 475	67 605	
Difference		11.25	6.60	7.86		$ 13 50	$ 5 945	$ 5 895	
Per cent Increase		16.27	7.97	8.71		16.27	7.97	8.71	

The average yields and values of the various lots of potatoes on the different days of digging shows wherein lies the greatest advantage (according to the Camden experiments) of the Northern grown seed, *i. e.*, early production. The average yield of the seven varieties on May 20 was 80.39 bushels from the Northern grown seed against 69.14 bushels from the second crop seed. The respective values of the two lots were $96.46 and $82.96, a difference of $13.50, or 16.27 per cent in favor of the Northern grown seed. When the second lot was dug, on June 1, the yields were 82.75 bushels from the second crop seed, and 89.35 bushels from the Northern grown. Their respective values on June 1 were $74.47½ and $80.42, a difference of $5.94, or 7.97 per cent in favor of the Northern grown seed, while the difference in favor of the latter on June 10 was $5.89½ or 8.71 per cent.

When the Northern grown seed were first planted for comparison with second crop seed in the spring of 1894 it was for the purpose of determining how much greater yield the latter would give than the former. Potato growers had agreed that second crop potatoes were the better seed from which to grow the early spring crop. The first year's experiment resulted contrary to expectations, and the test was repeated the two following years, both agreeing with the first year's trial, and all indicating that Northern grown seed will produce a greater yield of potatoes and earlier than the second crop seed, as will be seen from the foregoing results. There are several reasons why good Northern grown seed should give better results than the second crop, since the law of the survival of the fittest continues to operate in a majority of cases and like generally begets like. The Northern grown seed are developed under natural and favorable conditions and allowed to mature naturally, while the second crop is planted and grown in an unnatural season. The dry and hot weather retards both germination and growth, and the stunted plant is not capable of producing well developed fruit, while more favorable weather in the latter period of development induces a new growth followed by a killing frost which leaves the potatoes immature and poorly developed when growth ceases. Potatoes thus enfeebled could hardly be expected to produce offspring of as good development and sound maturity as others grown under favorable conditions. Another disadvantage that many growers inflict upon themselves is the use of only the small and immature culls for seed instead of large and well developed tubers.

Whether those differences in yield and earliness in favor of Northern grown seed will justify the Southern grower to buy his seed annually from the North, instead of growing a second crop for seed, must be determined by the growers themselves.

LARGE AND SMALL SECOND CROP SEED.

To ascertain the yields from large and small second crop seed four plots of Bliss Triumph were planted in 1896. For plot No. 1 only the largest and most perfect tubers were planted whole. For plot No. 2 small tubers, ranging from ¾ to 1¼ inches in diameter, were planted whole. Plot No. 3 was planted in cut tubers of the same size as those used on plot No. 1, and plot No. 4 in cut tubers of the same size as those used on plot No. 2. The result of the tests is given below.

YIELDS FROM LARGE AND SMALL SECOND CROP SEED.

Name of Variety.	Total Yield per Acre.	Merchantable Yield per Acre. Bushels.	Yield of Culls per Acre. Bushels.	Number of Days from Planting to Maturity. Bush's.
1. Whole Large Bliss Triumph	118.0	110.5	7.5	103
2. Whole Small Bliss Triumph	100.0	84.0	16.0	106
Difference	18.0	26.5	8.5	
Per cent Increase	18.0	31.5	53.1	
3. Cut Large Bliss Triumph	113.5	97.0	15.5	106
4. Cut Small Bliss Triumph	98.0	79.0	19.0	106
Difference	15.5	18.0	6.5	
Per cent Increase	15.8	22.7	34.2	

Large whole potatoes gave 18 per cent more total yield and 31.5 per cent more merchantable potatoes than whole small seed. Large potatoes cut gave 15.8 per cent more total yield and 22.7 per cent more merchantable potatoes than the cut small ones.

The large seed used in the test were from 2 to 3 inches in diameter and on plot No. 3 were cut to pieces of uniform size with from one to three eyes. The small seed averaged about an inch in diameter and were to some extent shriveled. For plot No. 4 they were cut into halves or quarters, according to size. As is almost invariably the case the large seed sprouted promptly, while the small seed came up slow and irregular, producing many small plants of unhealthy appearance, some of which made no tubers at all and others compact clusters of very small ones. Plot No. 1 was up to a perfect stand a few days before plot No. 3 and ripened three days earlier. Plots Nos. 2, 3 and 4 ripened about the same time, though there were some unripe hills on the small seed plots when harvested. The continuous planting of inferior seed for several generations will cause the variety to so "run out" by forced "in-and-in breeding" from sorry stock that it will not be worth planting. Nearly all of our cultivated plants have been improved and bred up to better form and substance and other desirable qualities superior to those possessed by the original plant, and have a natural inclination to revert to their degenerate original character, hence the greater care necessary for the continued production of these evolved and desirable characteristics by careful selection of seed and growing them under favorable conditions.

LEVEL VS. RIDGE CULTURE.

Many growers seem to think it necessary to hill or ridge their potatoes to secure a good crop. In a very wet season or on very wet land this is probably true, but for ordinary conditions and on land suited to potato growing level culture should be practiced. The ridge system will undoubtedly ripen the crop earlier than the level system, but will not produce a better yield except in the presence of excess of moisture. In 1896 a double series of plots were planted, the ridges varying from 12 inches high down to level. One series consisted of Bliss Triumph, and the other of Early Ohio. One-third of each plot was dug May 20, another third June 1, and the last on June 18. A very dry season seriously affected the yield and hastened maturity, but served to indicate to a marked degree the advantage of level culture, particularly for a dry season. The results will be found in the following table:

Name of Variety.	Height of Ridge.	Merchantable.	Culls.	Merchantable.	Culls.	Merchantable.	Culls.	Date Ripe.
		Dug May 20. Bushels.		Dug June 1. Bushels.		Dug June 18. Bushels.		June.
Bliss Triumph	Level.	81½	9½	98½	8¼	110	4¼	10
Early Ohio	Level.	88¾	13¼	127½	15	147	13½	10
Average	Level.	**85.12**	**11.37**	**131**	**11.62**	**128.5**	**8.87**	10
Bliss Triumph	2 in.	82½	8¾	94¼	8¾	95	6¾	10
Early Ohio	2 in.	85	14½	133	10¾	161	9¾	10
Average	2 in.	**83.75**	**11.62**	**113.62**	**9.75**	**128**	**8 25**	10
Bliss Triumph	4 in	72¼	14¾	81½	10¼	84¼	8¼	3
Early Ohio	4 in.	75	16¾	111	15	127½	7¾	3
Average	4 in.	**73.62**	**15.75**	**96.25**	**12.62**	**105.87**	**8**	3
Bliss Triumph	8 in.	60¾	13¼	66	18½	....	....	1
Early Ohio	8 in.	58½	17½	70½	18½	....	....	1
Average	8 in.	**59.62**	**15.37**	**68.25**	**18.5**	....	....	1
Bliss Triumph	12 in.	41	15¾	48¾	16	....	....	1
Early Ohio	12 in.	55¾	16	61	19¾	....	....	1
Average	12 in.	**48.37**	**15.87**	**54.87**	**17.87**	....	....	1

It was not possible to give the same cultivation to each plot and maintain the height of the ridge. This fact, together with the unusual dryness of the season and the sandy, porous character of the soil conspired together and emphasized the advantage of level culture.

The level and 2-inch plots were cultivated first broadcast with harrow and afterwards with a 20-inch heel sweep. The 4-inch ridge plots were cultivated with a 5-inch scooter and the middles thrown out with a 10-inch heel sweep. The 8 and 12-inch ridge plots were cultivated with small turning plow by first barring off the rows and afterwards throwing the soil back, a common method of culture in many sections of the South. Each plot was hoed once the latter part of April, and each had the same number of plowings. The potatoes planted on the 8 and 12-inch ridge ripened ten days earlier than those on ridges of but slight elevation, but when ripe produced less than half as many potatoes as the level and 2-inch plots. When dug on May 20, the level and 2-inch ridge plots produced an average of 84.43 bushels per acre, while plots with the 8 and 12-inch ridges produced only 53.99 bushels. When dug on June 1, the level and 2-inch ridge plots yielded an average of 113.31 bushels, and the 8 and 12-inch plots only 61.56 bushels per acre. In these comparisons only merchantable potatoes are referred to. The proportion of small potatoes was much greater in the high ridge plots than in those level or nearly level. The following tabulation will enable the reader to more easily appreciate the average of the level and 2-inch ridge plots when compared with the average of the 8 and 12-inch plots.

	Merchantable Yield in Bushels.		
	Dug May 20.	Dug June 1.	Dug June 18.
Average Level Plots	85.12	113.00	128 5
Average 2-inch Plots	83.75	113 62	128.0
Average	**84.43**	**113.31**	**128.25**
Average 8-inch Ridge Plots	59.62	68.25	68.25
Average 12-inch Ridge Plots	48.37	54.87	54.87
Average	**53.99**	**61.56**	**61.56**
Level Culture Increase	**30.44**	**51.75**	**66.69**
Increase per cent	**56.38**	**84.06**	**108.3**

The rainfall at Camden in the spring of 1896 was as follows:

March	5.34 inches.
April	4.86 inches.
May	1.08 inches.
June (from 1st to 10th)	.80 inches.

With the exception of 0.12 inches all the rain of April fell before the 13th of the month. Between April 13 and June 10, when the potatoes were mature, not enough rain fell to thoroughly moisten the soil. On June 3 the plots presented an interesting appearance. The vines of plots 7, 8, 9 and 10 were all dead, while 1, 2, 3 and 4 were green and growing, and 5 and 6 just ripe. The difference in the appearance of plots 1 and 9 and 2 and 10 were as great as the difference in the appearance of any of the plots of the variety tests, situated across a terrace.

The results of this test may appear marked and extreme, but the conditions that produced them are not uncommon in the southern portion of the State (and other portions as well) where light sandy soil, with porous subsoil prevails, and drouth and extreme heat are of frequent occurrence. On soil dry enough for Irish potatoes there is no possible advantage in cultivating them on a high ridge, as they have a tendency to decrease both the yield and the size of the potatoes, and increase the difficulties of cultivation.

VARIETY TEST.

On the 20th of February, 1896, four plots each of thirty-two varieties of potatoes were planted, and a plot of each harvested at intervals of about two weeks. The first were dug May 15, the second May 29, the third June 11, and the fourth June 22. The merchantable potatoes were sold immediately in the local market, and the yield per acre and the value of the product of each variety recorded. The soil upon which they were grown produced a crop of sweet corn in 1895. The corn was followed by cowpeas sown at the rate of 1¼ bushels per acre. In December of the same year about ten tons of stable manure per acre were equally distributed. The pea vines and manure were turned under the same month, at which time the soil was subsoiled to the depth of 15 inches. Early in March the field was harrowed level, and the harrowing repeated when half a stand was up. In both cases the harrow was drawn diagonally across the rows, and the surface left as level as possible. The first plowing was done with a small bull-tongue, the second with a 20-inch heel sweep run twice in a 36-inch row. The third and last plowing was done with a 24-inch heel sweep, one furrow being run to the row. The hoe was used but once, following the second plowing.

In addition to the stable manure applied the fall previous to planting, the potatoes were given a complete fertilizer in the drill at the rate of 2,000 pounds per acre. This was well incorporated with the soil by running two bull-tongue furrows in the drill after the fertilizers had been put down. The fertilizers were in the following proportions:

Acid Phosphate	700 pounds.
Kainite	700 pounds.
Cotton Seed Meal	600 pounds.
	2,000 pounds.

The potatoes dug May 15 were the first on the market, and retailed at $2 per bushel until the first shipment arrived by boat from New Orleans.

The results of the test are to be found in the following table, which gives the twenty varieties that gave the best returns, with date and yield of each digging, and the local market value of each variety when dug.

VARIETY TEST.

Name of Variety.	Date Ripe.	Merchantable Yield per Acre.				Value Product per Acre, May 15, $1.50 per Bushel.	Value Product per Acre, May 29, 90c per Bushel.	Value Product per Acre, June 11, 75c per Bushel.	Value Product per Acre, June 22, 65c per Bushel.
	June.	Dug May 15.	Dug May 29.	Dug June 11.	Dug June 22.				
1. Beauty of Hebron	10	70	140	180	....	$105.00	$127.80	$135.00	....
2. Bliss Triumph	3	80	122½	137½	....	120.00	110.25	103.12½	....
3. Burbank Seedling	18	42½	165	175	186	63.75	148.50	131.25	$120.90
4. Charles Downing	3	102	124½	150	....	153.00	112.05	112.50	....
5. Crown Jewell	6	125	190	215	....	187.50	171.00	161.25	....
6. Early Essex	6	83¼	91½	99½	....	124.87½	82.35	74.62½	....
7. Early Kansas	3	100	170	185	....	150.00	153.00	138.75	....
8. Early Ohio	3	90	185	190	....	135.00	166.50	142.50	....
9. Early Six Weeks	1	95	185	190	....	142.50	166.50	142.50	....
10. Early Six Weeks Market	1	120	180	190	....	180.00	162.00	142.50	....
11. Early Sunrise	6	57½	165	170	....	86.25	148.50	127.50	....
12. Everett	1	105	155	157	....	157.50	139.50	117.75	....
13. Mammoth Pearl	9	87½	90	145	....	131.25	81.00	108.75	....
14. New York Early Rose	3	72	160	162	....	108.00	144.00	121.50	....
15. Ohio Junior	1	147	184	231	....	220.50	165.60	173.25	....
16. Peerless	9	115	142½	170	....	157.50	128.25	127.50	....
17. Puritan	6	85½	99¾	116	....	128.25	89.77½	87.00	....
18. Snowflake	9	57½	85	130	....	86.25	76.50	97.50	....
19. Wood's Earliest	3	108¼	116½	116½	....	163.37½	104.85	87.32½	....
20. World's Fair	1	117	180	210	....	175.50	162.50	157.50	....

The five varieties giving the best results for early market were, in the order named, Ohio Junior, Crown Jewell, Early Six Weeks Market, World's Fair, and Wood's Earliest. The five varieties giving the highest yields when ripe were, in order named, Ohio Junior, Crown Jewell, World's Fair, Early Ohio, and Early Six Week's Market. Ohio Junior and Crown Jewell led in both cases.

The varieties named below were inferior to those named in the preceding table in yield and value:

Ajax, Boston Red, Burpee's Superior,
Freeman, Maggie Murphy, Richmond Bell,
American Wonder, Brownell's Winner, Clark's No. 1,
Irish Daisy, Monroe Seedling, Rural New Yorker No. 2.

DOES IT PAY TO USE PARIS GREEN FOR THE POTATO BEETLE?

Potato bugs were very plentiful about Camden in the spring of 1896, and but little effort was made to destroy them. The writer saw several fields completely defoliated before the vines were half grown. To determine to what extent the application of insecticides was beneficial, one of four plots of Bliss Triumph was sprayed and another dusted with Paris green, while the remaining two plots were left to the beetle. Paris green was applied twice, each time when the young beetles were quite small and before any material damage had been done by them. Upon the vines of the plots upon which the poison was not used but few leaves remained. Very slight damage was done the vines of the plots upon which the Paris green was used. A Legget powder gun and knapsack spray pump were used for applying the poison. The potatoes were harvested early in June and yielded as follows:

	Merchantable yield per acre in bushels.
Paris green dusted	94¼
No Paris green	79½
Paris green sprayed	89
No Paris green	81¾
Average Paris green	**91.62½**
Average no Paris green	**80.62½**
Difference	11 Bu. or 13.6%

The cost of the Paris green and spraying or dusting it on the plants was less than $2 per acre, while its application caused an increase of 11 bushels or 13.6 per cent per acre.

C. L. NEWMAN,
Agriculturist.

METHODS OF COMBATING COMMUNICABLE DISEASES OF FARM ANIMALS.

CONTENTS:—**Cause and origin of communicable diseases.**
General methods of prevention and control.
Inoculation against Anthrax or Charbon.
Prevention and control of Texas Cattle Fever.
Limitations of Experiment Station aid in this work.

The purpose of this bulletin is to describe as concisely as possible the methods which can be adopted in order to prevent or control the common communicable or spreading diseases of farm animals as they occur in this State. The absence in this and in most Southern States of any official veterinary service in dealing with contagious animal diseases makes it especially desirable that information of the kind sought to be conveyed by this paper should be widely diffused among the farming population. Although the methods recommended here are not new, being in fact only such rational means as should suggest themselves to all owners of live stock, it is a matter of common observation that they are generally neglected or carried out in a half-hearted and therefore ineffective manner. This is, no doubt, partly due to carelessness or doubt as to their utility, but more frequently to lack of precise information as to the details necessary for thoroughness in this work, and without thoroughness and attention to details success cannot be obtained. In the case of hog diseases in particular, the intelligent application of these rational methods of control must largely diminish the enormous losses which farmers yearly sustain in all parts of the State.

The methods of control and prevention here described are applicable to contagious animal diseases in general, hence a diagnosis or identification of the disease is not indispensable to their use. This matter of identification of particular diseases of stock, when of a contagious nature, is in all cases desirable, but will often have to be dispensed with. Some admit of positive recognition during life, others only by skilled dissection and examination after death, while some of the diseases to which the domesticated animals, hogs, sheep and poultry, in particular, are subject in this country remain as yet unstudied.

Certain modifications which are necessary in combating particular diseases will be referred to separately.

Some account of the nature and mode of origin of communicable diseases is necessary to a correct understanding of the principles underlying their prevention and control. This will be given in the briefest and plainest manner possible.

CAUSE AND ORIGIN OF COMMUNICABLE DISEASES.

The word communicable as here used refers to the property of such diseases to spread from one animal to another. Contagious, infectious, and "catching," are words commonly used to indicate the same thing, although less comprehensive in their meaning, as all communicable diseases are not contagious, that is, do not extend directly from one animal to another. Most of the spreading diseases of stock, however, those that are most frequent and most fatal, are transmissible by contagion.

All communicable diseases are parasitic, using the term in its widest sense; that is, they are caused by the growth of lower forms of life, animal or vegetable, on or in the body of the diseased animal. More frequently the term parasitic is restricted to those affections which are caused by the presence of animal parasites, such as worms, insects, etc., which are of comparatively large size.

The most common and destructive contagious diseases are caused by minute vegetable organisms known as bacteria or disease germs. These are the essential elements of the contagion and are cast off from the body of the diseased animal in various ways, usually in the discharges from the nose, bowels, and skin. They retain their vitality and disease producing power outside the body for a variable period, days, weeks, or months, according to the disease and the atmospheric conditions to which they are subjected. From this it is plain that not only the diseased animals, but the places where they have been confined are sources of danger to healthy animals, a circumstance which greatly increases the difficulty and expense of controlling outbreaks of contagious diseases of animals.

The origin or starting point of any outbreak of diseases of this kind on a farm can be referred in practically all cases to exposure to similarly diseased animals or to their discharges.*

This fact constitutes the basis of the ordinary methods employed in combating contagious diseases.

As to the ways by which exposure occurs the most usual are:

(1) *The introduction of diseased stock.* This is one of the most frequent ways by which disease is introduced on a farm. It applies to all the communicable diseases to which live stock are liable, since all of these have a certain period of incubation during which no outward manifestations are present. The result in some cases is seen almost at once, while in others it may be delayed for weeks and even months. In hog cholera and chicken cholera, for instance, the recently introduced animals may set up disease within a few days, while in Texas fever, tuberculosis, and glanders, the symptoms of disease may not appear for a longer time.

(2) *Exposure of the animals on a farm to diseased stock of neighbors* is next in importance. In some cases it is even more important than the former. This is the case when free mingling of the stock occurs on account of poor fences or common pasture ground. As described above, this exposure may not be directly to diseased animals, but to the pens, stables, and even pastures, where these have previously been confined.

(3) Contagion may be carried in *drinking water* contaminated by diseased animals higher up the stream. This is probably a common cause of outbreaks of hog cholera.

(4) It may be carried in various ways, which need not be enumerated, through the agency of man, dogs, birds, insects, etc. These are,

---

*There is a possibility that certain so-called "filth diseases," which may include hog and chicken cholera, diarrhœa of young calves, etc., may in some cases originate spontaneously from bad hygienic surroundings and subsequently extend by contagion. This theory, which implies the acquirement or increase of pathogenic properties in bacteria usually saphrophytic, even if it should be proved for the diseases above mentioned, would not diminish the need of protection against contagion.

however, modes of transmission which are probably not of frequent occurrence.

Endemicity of disease, that is, its apparently permanent establishment in certain regions or on certain farms, applies especially to infection with parasites such as the common fluke disease of cattle (Second Annual Report, 1889, of this Station). "Blackleg" of cattle also shows this characteristic. In these cases the soil or water supply on the farm becoming infected contributes to the perpetuation of the disease.

Finally, it may be added, that all unhygienic conditions tend to diminish the resisting power against disease.

It is important to be able to distinguish between diseases which are actually communicable from animal to animal, directly or not, and those outbreaks which occasionally occur but in which there is no spreading in this way. A number of animals on a farm, for instance, may be attacked with some disease at the same time or in quick succession on account of some unfavorable conditions affecting all of them at the same time, the most common cause of such outbreaks being the use of some improper kind of food. Outbreaks of this kind may erroneously be considered contagious. It is always best to be on the safe side, and unless the cause is certainly discovered treat such cases as communicable diseases.

Methods of prevention of outbreaks of contagious diseases of animals on a farm are simply the means by which exposure to infection is avoided. This is the way we almost instinctively adopt to protect ourselves from the infectious diseases to which the human race is subject, and it applies with equal force to those of the domestic animals.

It need hardly be said that such precautions are especially needed when any stock disease is known to be prevailing in the neighborhood.

From what has been said of the ways in which exposure to contagion is brought about, the methods of avoiding such exposure at once suggest themselves.

Newly purchased animals should never be allowed at once to mingle with others on the farm unless it is positively known that the stock on the farm from which they come is free from disease. This applies to all species of animals.

The purchaser of high-priced cattle of the improved breeds should insist on a guarantee of freedom from tuberculosis as shown by the tuberculin test. In nearly all regions where such stock is raised a veterinary surgeon can now be obtained capable of applying this test which furnishes the only guarantee of any value against this disease.

Newly purchased hogs should in nearly all cases be isolated for some time as a protection against cholera. Even if there is no suspicion of the herd from which they came they may still have been exposed to infection in transfer.

As infection-carrying animals are not always themselves manifestly diseased, newly introduced hogs may be tested by penning them for three weeks or so with two or three of the younger and least valuable of the hogs on the farm. After that time if no disease appears they may usually be considered safe. These precautions, which apply also to poultry, are simple and inexpensive, but are sufficient to obviate one of the most common ways in which hog cholera is introduced into sections of the country where it was unknown before.

The *prevention* of exposure to diseased stock of neighbors is, of course, largely a question of fencing. A fence, however, even if "hog proof," is not contagion proof if diseased and healthy animals are on opposite sides of it. All keeping of stock on the public roads should be prohibited by law, both in country and town, as this is a frequent means of spreading disease. Those who have no other place to pasture their hogs and cows might well turn their energies in some other direction and leave the raising of live stock to farmers. It may also be mentioned here that dogs in various ways contribute to the spread of disease in other species of farm animals and in human beings as well. The keeping of dogs is a luxury which the farmer can well afford to do without.

The water supplied to stock besides being an occasional carrier of contagion from one farm to another, as already mentioned, may be, in other ways, a source of disease. The best water is obtained from properly protected wells of some depth. Shallow wells in low places and without protective curbing are little better than stagnant pools. The most convenient water supply to stock is from rivers or streams. This water is also good, and in general unobjectionable unless the stream is very small. If small and almost drying up in summer drouths it is less convenient and much less safe. Swamp water and stagnant pools are quite unsuitable. The parasitic diseases of animals which are occasionally fatal and often harmful to health are very frequently dependent on such impure water.

The following may be given as general rules for the prevention of parasitic invasion: Water supply should be from wells, and wet and undrained pastures should be avoided. The pasture or "run" of animals should be of sufficient size; if too small, resulting in overcrowding, it favors parasitic invasion and finally the outbreak of fatal diseases of various kinds. This fact is well known to the poultry keeper, and it applies also to other kinds of stock. If too large, that is, embracing nearly all the farm, as is often the case with hogs in the South, then there is no opportunity for change, and disease once starting is much harder to control. The hog lot, poultry lot, etc., of one or two years, should then make part of the corn field. Alternation of crops is one of the most fruitful ways of combating endemic diseases of stock on a farm.

Preventive inoculation against disease is better considered as a method of control and will be discussed later.

Prevention of hog cholera, chicken cholera, roup, and other diseases, by administration in the food of drugs, condition powders, etc., largely advertised for this purpose, is a method which the farmer is naturally inclined to adopt on account of its convenience. Most of these "preventives" are probably harmless, except in so far as they may lead the too credulous farmer to neglect other rational measures. None have ever been shown to possess the preventive properties claimed for them, when put to actual test.

Methods of Control.—The measures to be adopted when some stock disease has actually broken out on a farm can be given briefly as the explanation for each of these procedures has been already described.

Isolation of diseased stock at once on discovery should, wherever practicable, include isolation of the lot, pens, or even field on which they have been. In cases where the stock have had nearly the run of the whole farm this will often be inconvenient. If early recognized, an alternative, though less sure in its results, is to remove the sick into an isolated pen. The others should at the same time be restricted in their range and carefully watched. Any new cases which develop have to be separated at once, separation being best effected by removing the others to a new inclosure and either leaving the sick where they are or placing them in a special pen. Which of these methods is best will depend upon special conveniences in each case. A further separation of the same kind is required if new cases of sickness occur. In this way the disease may be checked and at the same time the extent of infection of the farm limited. It is of course quite essential that a complete separation of the well and sick be effected, and that all ways by which contagion may be transferred must be avoided. There must be no water carrying of contagion by surface washing or otherwise. Separate feeding buckets, etc., are needed, and it is best to have a separate attendant for each pen if these have to be entered.

Disinfection is hardly applicable to fields and large pens except by natural processes and cultivation. Smaller pens or lots which have held diseased animals are also best left vacant (or they may sometimes be safely used for other kinds of stock not liable to the disease in question) as long as practicable. A coating of lime to the ground assists in disinfecting it. Sheds, stalls, and stables, are to be disinfected by first thorough cleaning out and burning all bedding, etc., scrubbing or scraping woodwork and walls, and the liberal use of some chemical disinfectant, such as corrosive sublimate (one part in one thousand of water) or chloride of lime. The walls, should be then whitewashed and the places left vacant and subject to free ventilation and sunlight for at least several months. Pig pens and houses which have sheltered hog cholera cases can often be most profitably disposed of by burning them up. Dead animals should be buried deeply and covered with a layer of quicklime. Cremation is still better, but not easily carried out in a thorough manner.

Preventive inoculation as a means of controlling live stock diseases has, so far, a very limited application in this country. It was introduced some years ago to limit the ravages of hog cholera, but abandoned again on account of unsatisfactory results. Anthrax and black-quarter (or black-leg) two diseases endemic in certain regions of European countries, have long been combated in part by inoculation, and the practice is now being introduced into this country. While admitting the value of the original scientific work which led to its employment, and without denying its utility in European countries, it is questionable if the indiscriminate use of preventive inoculation against anthrax or "charbon" is to be recommended in this State; the cases here and in European countries where it is employed being not at all parallel. The disease can hardly be said to be endemic in any part of this country, only a very few outbreaks having been at any time positively identified as anthrax. Preventive inoculation or vaccination against anthrax is in my mind not free from a suspicion of tending to perpetuate the disease and even introducing it into regions where it was before unknown. It may be safely asserted that no vaccination should be allowed unless in regions where the disease already prevails, as determined by competent authority, and that other rational means of suppression should not be neglected, and, in fact, that the method, if it find acceptation in this country at all, should be under official State or Government control.

In the case of the disease called "black-quarter" in young cattle, the ordinary preventive inoculation or vaccination is perhaps less open to these objections, but here also its employment in uninfected regions is not to be recommended.

In their application, the foregoing methods of prevention and control would require modification or extension in the case of certain animal diseases. They are hardly available against the so-called "distemper" of horses, for instance, and glanders and tuberculosis in horses and cattle, respectively, can hardly be eradicated without the personal services of a veterinarian. Fortunately neither of these diseases are common in this State.

PREVENTION AND CONTROL OF TEXAS FEVER.

Texas fever or acclimation fever, as it is sometimes called, is the most important communicable disease of cattle in Arkansas. By the aid of previous bulletins on this disease (Bulletins 2 and 20) it may generally be recognized by the owner if at all observant of such matters. The conditions under which it occurs are also described in these reports, which should be consulted in conjunction with this.

Modes of prevention will vary according to whether the locality is "infected" or not, and this information is to be derived mainly from previous experience in cattle movements in that neighborhood. If cattle moved in from a Northern State are known to be liable to die during their first summer the region may be considered infected. In some places the imported stock may come only from a short distance and suffer the same fate. If, on the contrary, the imported stock remain well while the natives are attacked, the disease is not endemic and the place not permanently infected. The presence or absence of cattle ticks in any region is also considered by some to be an indication as to whether or not it is a Texas fever infected region, but this is hardly to be relied upon as a test.

To prevent fatality from Texas fever in imported Northern stock it is recommendable to import calves only and in the fall or winter. At all times, but especially in the hot months of the year, the cattle should be protected as much as possible from invasion of cattle ticks. Although it may be hardly possible practically to keep cattle entirely free from ticks in a locality where these are abundant, it is possible to afford at least a certain amount of protection. A sudden invasion of a susceptible animal by large numbers of ticks, is likely to produce an acute and fatal attack of Texas fever, while small numbers may presumably excite only a mild attack. To protect cattle from tick invasion, the following method given in an earlier report from this Station, based upon experiments made at that time (Bulletin No. 20, 1892,) will be found most suitable when only a small number of animals are to be treated.

"If already present and large enough pick the large ones off by hand or rub them off with the currycomb, going over the whole body carefully and destroying all ticks thus removed. Then give the cattle a thorough and complete wash with kerosene emulsion or an emulsion of the kerosene extract of pyrethrum prepared according to directions given below, giving special attention to those parts of the body where ticks are mostly found.

"Repeat this process at least once a week during the summer months while ticks are prevalent.

"Avoid turning cattle which it is desired to protect, into fields with thick matted growths of old grass, much underbrush, or into those which have been much pastured by other cattle bearing ticks on their bodies."

Either of the formulæ here given may be used. The first one combines the insecticidal effects of both pyrethrum and kerosene. These preparations are useful for the destruction of insects of all kinds parasitic on the bodies of animals, and are also used as a spray for cleansing poultry houses and for the destruction of insects injurious to vegetation.

"*Pyrethro-kerosene emulsion.* (1) Mix 1¾ pounds pyrethrum in one gallon kerosene; after twenty-four hours decant the fluid. (2) Dissolve one pound soap in one gallon boiling water.

"Remove the soap and water away from the fire, add the kerosene extract at once and mix thoroughly by means of a large syringe or force pump. Ten minutes' mixing will form an emulsion.

"This stock emulsion can be kept indefinitely. For use on cattle or other animals it should be diluted with four parts water which gives an emulsion containing about 10 per cent kerosene and the extract from 2 per cent of pyrethrum.

"*Kerosene emulsion.* Dissolve in two quarts of water one quart of soft soap or ¼ pound of hard soap by heating to the boiling point, then add one pint of kerosene oil and stir violently for from three to five minutes. This is best done by pumping the liquid into itself through a small nozzle so that it shall be thoroughly agitated.

"For use this can be diluted with about an equal volume of water.

"About one-half to one gallon of the diluted emulsion will be required for each animal if put on with a cloth or brush."

In the case where the number of cattle is too great or their individual value insufficient to justify so much labor, the best that can be done is to keep them out of the woods and underbrush where ticks are most numerous. The feeding of sulphur with the aim of keeping ticks off cattle is a delusion as was shown by tests made at this Station in 1892. Dipping of cattle in tanks has not, so far, proved to be quite successful.

Inoculation as a preventive against Texas fever is also yet in its experimental stage.

In noninfected regions where the native cattle are susceptible, chiefly in the northern counties of this State, the prevention of Texas fever is obtained by avoiding the introduction of tick-bearing cattle. A better guide is found in the history of previous shipments of cattle from any locality. A suspected lot of cattle should not be allowed at once to mix with native stock, but should be at once isolated. To free them from ticks and render them harmless the following method is recommended: Place them in a small field by themselves for three to four weeks, then transfer them to another for the same length of time. After this they will probably be free from ticks and can mingle with native stock. Their original power for conveying disease can be tested by placing two or three of the least valuable of the native cattle in the first field in which these suspected cattle were confined and observing whether or not any sickness results after an exposure of several weeks.

The *control* of outbreaks of Texas fever, after its introduction by infection bearing cattle, is not a difficult matter on a well fenced farm, but on the open ranges the case is different. It is, however, among cattle on the range and among town cows on common pasture that the disease chiefly prevails in this State.

On the farm the disease is controlled by removing the cattle yet unaffected to another field. If any of these sicken later, or if they appear to be tick-infested they have to be treated in the manner already given to free them from these parasites. The original field on which the disease first appeared has to be left vacant of cattle during the remainder of the year. On the range the same method has to be followed. If the infected parts of it can be localized in time these may be fenced off, but in general all that can be done is to establish a quarantine embracing the whole region where the cattle are dying, in order to prevent its extension.

When Texas fever occurs among cows pasturing in common around or in a town, a frequent occurrence in the northern part of this State, protection can only be obtained by keeping them off the common or streets until winter.

The aid that the Experiment Station can furnish in the suppression of live stock diseases is limited by the law controlling the expenditure of its funds to the diffusion of information, such as is contained in this report, and of such other information as may be learned from original investigations of disease. Advice can also be given by mail in reference to outbreaks of disease, and in certain cases, where it is thought that a favorable opportunity for investigation offers, a personal visit may be made. State veterinary sanitary work, which includes the examination into all outbreaks of contagious disease in live stock and the superintendence of the various procedures necessary for its suppression cannot be undertaken by the Experiment Station. It has neither the legal authority nor funds available for this purpose, and each community concerned must therefore undertake such work itself. With this limitation the Station will be glad to coöperate and aid in the control of stock diseases and invites correspondence on this subject.

R. R. DINWIDDIE.

EDING VALUE OF WHOLE COTTON SEED, CRUSHED TTON SEED, AND COTTON MEAL AND HULLS FOR FINISHING STEERS FOR MARKET.

A 90 days' feeding of cotton meal and hulls, ground cotton seed and whole cotton seed to steers was tried in the winter of 1897 and 1898 to secure results for those who are in doubt as to whether meal and hulls or seed should be used to finish off steers for beef when the relative market values of the foods are not the same. Feeders are usually cotton farmers and have the seed on hand, whereas the meal has to be bought and hauled, and when it is bought the seed is usually sold and has to be hauled to the railroad or to an oil mill, if one is in the vicinity. Ordinarily when meal and seed are at the railroad the meal in the seed sells for about the same price per ton as meal. But in favor of the seed on the farm is the value of the hulls on the seed, the cost of hauling the seed to the railroad and the cost of hauling back the meal. In feeding seed and meal the weather is also a factor in influencing the results, though it is not often taken into account, but in this trial its influence was observed as far as was possible.

In making this experiment three lots of five steers each were used. One lot was fed cotton meal and cotton hulls in the same proportion as they exist in the seed; to one lot crushed or ground seed was fed, and to the third lot whole cotton seed was given. To each lot cowpea hay was fed.

The steers were allowed to eat as much hay and cotton seed products as they desired, but the ratio of cotton meal and hulls was kept constant in the lot to which they were fed. This was an easy thing to do, because the steers preferred hulls to hay. The total hulls fed shows a slight excess of the ratio, but that is due to feeding all the hulls that the steers would eat during the last week of feeding to see the extent of the preference for hulls to hay. The ground seed was prepared by grinding or cutting them with rapidly revolving knives in a mill made for that purpose. The kernels of the seed were not separated from the hulls, though the mill was fitted with a separator. Ground seed was fed to one lot in order to ascertain if in that form the seed would be more palatable and make better gains than whole seed. The expense of grinding was 50 cents per ton with hired power. The expense would also include separating the kernels from the hulls. The steers were fed separately in each lot in large box stalls that opened into small lots. The quality of pea hay was first-class, and the quantity of hay and cotton seed products fed at each feeding was determined by the manner in which the foods were eaten at the last feeding. All the data of the experiment are exhibited in the subjoined tables, each lot separately. The weights of the steers were determined by weighing in the morning before any food or water had been given.

FIVE STEERS FED COTTON MEAL, COTTON HULLS AND COWPEA HAY.

No. Steers.	Weight Nov. 16.	Weight Jan. 15.	Gain 1st 60 days.	Weight Feb. 15.	Gain 3d 30 days.	Total Gain.
1	828	922	94	974	52	146
2	784	882	98	941	59	157
3	724	840	116	906	66	182
4	762	902	140	982	80	220
5	702	845	143	923	78	221
5	3,800	4,391	591	4,726	335	926

AVERAGE WEIGHT AND GAINS.

	Average Weight Nov. 16.	Average Weight Jan. 15.	Average Gain 1st 60 days.	Average Weight Feb. 15.	Average Gain 3d 30 days.	Average Total Gain.
	760	878	118	945	67	185

AVERAGE GAIN PER DAY.

	Average Gain per day for 1st 60 days.	Average Gain per day for 3d 30 days.	Average Daily Gain for 90 days.
	1.9 pounds.	2.2 pounds.	2 pounds.

FOOD CONSUMED IN 90 DAYS.

Cotton Meal.	Cotton Hulls.	Cowpea Hay.
2,189 pounds.	2,900 pounds.	6,252 pounds.

FIVE STEERS FED WHOLE COTTON SEED AND COWPEA HAY.

No. Steers.	Weight Nov. 16.	Weight Jan. 15.	Gain 1st 60 days.	Weight Feb. 15.	Gain 3d 30 days.	Total Gain.
1	726	861	135	902	41	176
2	740	862	122	940	78	200
3	724	810	86	838	28	114
4	906	1,044	138	1,108	64	202
5	710	842	132	882	40	172
5	3,806	4,419	613	4,670	251	864

AVERAGE WEIGHT AND GAIN.

	Average Weight Nov. 16.	Average Weight Jan 15.	Average Gain 1st 60 days.	Average Weight Feb. 15.	Average Gain 3d 30 days.	Average Total Gain.
	761	883	122	934	50	173

AVERAGE GAIN PER DAY.

	Average Gain per day for 1st 60 days.	Average Gain per day for 3d 30 days.	Average Daily Gain for 90 days.
	2 pounds.	1.6 pounds.	1.9 pounds.

FOOD CONSUMED IN 90 DAYS.

Whole Cotton Seed.	Cowpea Hay.
4,609 pounds.	6,591 pounds.

FIVE STEERS FED GROUND COTTON SEED AND COWPEA HAY.

No. Steers.	Weight Nov. 16.	Weight Jan. 15.	Gain 1st 60 days.	Weight Feb. 15.	Gain 3d 30 days.	Total Gain.
1	800	926	126	988	62	188
2	730	920	190	966	46	236
3	782	888	106	914	26	132
4	736	815	79	872	57	136
5	778	908	130	944	36	166
5	3,826	4,457	631	4,684	227	858

AVERAGE WEIGHT AND GAIN.

Average Weight Nov. 16.	Average Weight Jan. 15.	Average Gain 1st 60 days.	Average Weight Feb. 15.	Average Gain 3d 30 days.	Average Total Gain.
765	891	126	936	45	171

AVERAGE GAIN PER DAY.

Average Gain per day for 1st 60 days.	Average Gain per day for 3d 30 days.	Average Daily Gain for 90 days.
2.1 pounds.	1.5 pounds.	1.9 pounds.

FOOD CONSUMED IN 90 DAYS.

Ground Cotton Seed.	Cowpea Hay.
4,630 pounds.	6,535 pounds.

While these steers were all of good grade and under four years they were unsatisfactory feeders, only one making an average gain of two and one-half pounds per day. They gained less than any steers that the Station has ever fed on those foods, and yet they consumed relatively as much food as any previously fed. When weighed at the end of the first 60 days of the feeding the gains of the lots for that period were reversed by the succeeding 30 days. The lots that made the most gain for the first 60 days made the least during the final 30 days. Ground cotton seed made 2.1 pounds for the first 60 days, whole seed made 2 pounds per day, and cotton meal and hulls 1.9 pounds per day. The steers were not fat when feeding began, as they had been from the range on a corn-stalk field only for a short time. The appetites of each lot were increased by cold weather and diminished by warm and sultry weather. The two seed lots being more affected by the warm and sultry weather than the meal and hulls lot. Feeding was during the part of the year—November 15 to February 15—that is usually cold, but this winter was very mild, 13 degrees above being the lowest temperature, and that occurred only once. But the warm weather does not entirely account for the small gains. The reader can use the price that the foods command in his vicinity for estimating the cost of the feeding.

The following is the proportion or quantities of mill products obtained by oil mills from 100 pounds of cotton seed:

Meal	37.5	pounds.
Oil	12.5	"
Hulls	48.9	"
Lintel (short lint from reginning)	1.1	"
Total	100.0	"

REMARKS ON THE RESULTS OF THE TRIAL.

The lot fed cotton meal and cotton hulls had a better appetite for food at each feeding than the lots fed cotton seed. Cotton hulls were preferred to cowpea hay. The meal was eaten first, then the hulls and then the hay. Whether the hulls were preferred because less rich cannot be determined in this trial. The preference shown for hulls would indicate that the hay, or a part of it, could have been omitted without any loss in gains and at a cheapening of the cost of feeding.

The lot fed ground cotton seed did not appear to have any sharper appetite for ground seed than the other lot for whole seed. These steers, however, showed a decided preference for the kernels of the seed, especially as the feeding period progressed. They endeavored to select them from the hulls as far as this was possible before eating the hulls. This seems to indicate that the ground seed could be fed to better advantage by feeding the kernels and hulls separately, more seed perhaps would be eaten and less hay would be required and perhaps a hay of lower food value would be sufficient. Unless the hulls and kernels are separated when ground there is no increase of consumption by grinding the seed for feeding 90 days.

The lot fed whole cotton seed had as good appetite at the end of the 90 days as at the beginning, and suffered no derangement of the bowels. This exemption was enjoyed as well by the other two lots.

The average gains per day for each lot during the 90 days was 2 pounds for the lot fed cotton meal, hulls and hay, 1.9 pounds for lot fed whole seed and hay, and 1.9 pounds for lot fed ground seed and hay. In a former feeding trial of cotton seed and cowpea hay to two steers for 90 days, the average gains per day were a fraction above 3 pounds (Bulletin 41). In a similar feeding in another trial two steers were fed all the cowpea hay they would eat, but were limited to 4 pounds of cotton seed per day, and their gains were an average of 1.9 pounds (3rd Rep.). In that feeding the steers had an insufficiency of seed, but in the above experiment they had all the seed they would eat. Before the first weighing of the steers it was expected that those steers that were fed cotton meal and hulls would show a large gain over the seed lots, because of the greater eagerness of that lot for its food, but the expectation was not sustained by the scales. The seed lots did not appear to have as good appetite, but they would finally eat their food about as well as the meal and hull lot, and exceeded that lot in gains for the first 60 days.

RESULTS.

As to results from this trial bearing on the object of the experiment—whether cotton meal and hulls is a better food than cotton seed for finishing off steers—we can only say that meal and hulls made a larger gain in 90 days than seed; that seed made a larger gain in 60 days than meal and hulls. The difference between the two for either period could be attributed to the individuality of the steers if the gains for the 60 and 90 days did not reverse each other. From the gains we may assume meal and hulls to be superior for long feeding, and that seed is as good if not better for feeding as long as 60 days.

This trial suggests the practice, when meal and hulls sell for more than seed, or when they sell for relatively the same price, of feeding seed during the first part of the feeding period, not exceeding 60 days, and of feeding meal and hulls during the last part of the period.

The excess of oil in seed over that in meal would seem to be the cause of the diminished appetite of the seed steers when the weather was warm and sultry. The diminished appetites suggest that when seed is to be fed without any meal, either corn or bran should partly or wholly replace the seed when the weather affected the appetites to any extent during the last part of the feeding.

Feeding seed as the only concentrated food for *fattening* should be done only during the cool part of the year.

R. L. BENNETT.

A REPORT OF PROGRESS OF INVESTIGATION IN THE CHEMISTRY OF WHEAT.

By G. L. Teller.

ARRANGEMENT.

I. PURPOSE AND PLAN OF EXPERIMENTS.

II. CERTAIN CHARACTERISTICS OF THE ALCOHOL-SOLUBLE PROTEID, GLIADIN, AND THEIR BEARING ON THE IDENTITY OF THE PROTEID DESIGNATED BY OSBORNE & VORHEES AS A "PROTEOSE."

III. QUANTITATIVE METHOD FOR THE DETERMINATION OF THE PROTEIDS OF WHEAT.

IV. RESULTS OF THE APPLICATION OF THE QUANTITATIVE METHOD OF DETERMINING PROTEIDS APPLIED TO SERIES OF WHEAT SAMPLES.

  1. WHEAT CUT ON EACH CONSECUTIVE DAY DURING FORMATION AND RIPENING, AND DRIED ON STRAW.

  2. WHEAT OF THE SAME SAMPLES DRIED IN HEADS CUT FROM STRAW WHEN GATHERED.

V. THE ENDOSPERM OF WHEAT. METHOD USED FOR OBTAINING IT FREE FROM BRAN AND GERM. RESULTS OBTAINED BY APPLYING THE ABOVE METHODS OF PROTEID DETERMINATION TO THE ENDOSPERM SEPARATED FROM A PART OF THE SAMPLES OF THE SERIES DRIED ON STRAW.

VI. PROXIMATE COMPOSITION OF GROUPS OF THREE CUTTINGS EACH OF THE SERIES OF WHEAT DRIED ON STRAW.

VII. CONCLUSIONS.

VIII. WEATHER RECORD FOR APRIL, MAY AND JUNE FOR YEAR OF THE HARVEST, 1897.

A valuable contribution to the science of agriculture and to the existing knowledge of the physiology of plants was made when Dr. R. C. Kedzie first published a report[1] of his very careful investigation on the chemical changes which occur in the wheat grain during its formation and ripening. The information there given has been confirmed and extended in his more recent investigations the results of which have been published[2] within the last few years. These investigations have shown the changes in the relative proportions of proteids, amides, ash, fats, fiber, and carbohydrates which occurs in the grain dried on the straw after harvesting on each successive day during the time from its formation to several days past ripeness.

---

[1] Report of Michigan Board of Agriculture, 1881-82, p. 233. Reprinted 1885, p. 121.

[2] Michigan Experiment Station Bulletin, No. 101.

The extensive and very valuable investigations of Osborne & Voorhees of the Connecticut Experiment Station[3] on the nature of the different proteids contained in the wheat grain have thrown much light upon the nature and chemical constitution of gluten, the amounts and consistency of which in different wheats and flours is universally recognized as a most valuable index as to their quality for breadmaking and other purposes for which they are used.

More recently the writer has carried on investigations[4] with the hope of formulating a ready method for making a quantitative separation of these different proteids of wheat and it is believed that sufficient success has been attained to warrant confidence in their use for certain other studies which have been undertaken. So, too, methods have been recently developed which are more or less applicable for a quantitative separation of the various substances which are usually classed together under the general name of carbohydrates.

The availability of these recently developed analytical methods and the importance of the information which they seemed likely to give when used in this connection, has led to the undertaking of an extension of the work of Dr. Kedzie as outlined. The proposed extension was to make a quantitative separation of the components of the proteid and carbohydrate groups so as to learn of the changes which occur in the proportions of these various components during the period indicated. The possibility, too, of a variation of the data obtained by Dr. Kedzie owing to the difference in climate between Michigan and Arkansas encouraged the undertaking of the work.

Early in May, 1897, when wheat was coming into head, a half acre of the growing grain was purchased of a neighboring farmer for use in the proposed experiment. The wheat was selected because of its good growth and apparently uniform quality. It was by far the most suitable which could be obtained within reasonable distance at that time. Even then it was so distant and so difficult of access that it was necessary to employ a farmer to bring a portion to the laboratory each day. As the wheat matured it did not show the uniform quality which was expected from its earlier appearance. It was apparently more or less affected in places by a springy soil and other irregularities. These facts account for the distressing variations which occur in the results where under favorable conditions uniformity would be expected. However, in some respects even these irregularities seem to help strengthen conclusions which may be drawn from the data obtained.

---

[3] American Chemical Journal, Vol. XV. No. 6.

[4] Arkansas Experiment Station Bulletin No. 42. Part II.

On May 22, when the wheat was past blossoming and the grain was set a portion was cut and this was repeated at the same hour on each of forty-one successive days. Six small bundles were brought to the laboratory each day. In the earlier days the weight of the fresh material was 80 to 90 pounds. It diminished to about 50 pounds as the wheat ripened. About one-half of each cutting was spread directly on poultry netting stretched in the loft of well ventilated barns. When sufficiently dry it was concentrated into bundles and allowed to remain until threshing time. Of the other half the straw was clipped with shears immediately below the head as soon as brought to the laboratory. The heads were carefully dried and hung in sacks in the station building.

The summer of the year in which this wheat was gathered was unusually dry throughout. The time and amounts of rain and the temperature are shown in the appended weather table. About the last of September the wheat was threshed and cleaned. That used for analysis was carefully hand-picked to free it from all foreign matter.

The threshing was done by means of an old threshing-machine cylinder, with concaves, run by a small gasoline engine. The straw and grain were received from the cylinder into a closed box, which was thoroughly cleaned after the threshing of each sample. The chaff was winnowed from the grain by the use of an ordinary farm fan. The yield of each sample, except of the very early cuttings, was from three to four quarts.

One notable exception to this was No. 33, which yielded nearly one-half more grain from apparently the same amount of straw. The results of the analysis of this sample show it to be an irregular in nearly every respect. No special cause can be assigned for it and it is for the most part treated as other samples in averaging the results.

As a comparison of the development of the wheat kernel from day to day during the period of the cutting, the number of kernels in ten grams of each sample has been determined. In making these determinations 100 grams of each sample were counted and the results divided by ten. In a few of the earlier cuttings less weight was counted. The results for the grain ripened on the straw are given below:

NUMBER OF KERNELS IN TEN GRAMS OF WHEAT RIPENED ON STRAW.

Number of Cutting.	Number of Kernels.	Number of Cutting.	Number of Kernels.
1	3583	22	312
2	2851	23	299
3	2946	24	277
4	2510	25	277
5	1956	26	266
6	1407	27	264
7	1200	28	254
8	1163	29	251
9	877	30	256
10	885	31	261
11	756	32	258
12	598	33	240
13	515	34	251
14	524	35	253
15	454	36	253
16	409	37	251
17	417	38	250
18	410	39	239
19	381	40	249
20	315	41	249
21	304	42	246

For various reasons the samples of the wheat series have been arranged in different parts of this publication in groups of three each. Results of analyses have been obtained for each group in some instances by averaging the results of the analyses of the three samples separately, and in other instances as indicated later, by analyzing a mixture of equal weights of the three samples. Of these groups I corresponds to the first three cuttings, II to the second three cuttings, and so on throughout the series. The approximate stage of development of the grain for each of these groups is as follows:

STAGE OF DEVELOPMENT OF WHEAT WHEN CUT.

Roman numerals indicate number of the group of three cuttings each. Figures in parenthesis indicate numbers of the cuttings.

I. (1, 2, 3) A little past blossom. Grain set.

II. (4, 5, 6) Berries one-half to full length of ripe grain.

III. (7, 8, 9) Crushed berries exude a thin milky liquid. Lower leaves beginning to die.

IV. (10, 11, 12) Grain well in milk.

V. (13, 14, 15) Heads and kernels well developed. Interior of the grain a thin dough.

VI. (16, 17, 18) Grain in dough.

VII. (19, 20, 21) Grain in stiff dough. Straw becoming yellow at butt. Grain shells a little with rough handling.

VIII. (22, 23, 24) Straw in field much yellowed but still decidedly green.

IX. (25, 26, 27) Grain oozes a thin liquid when crushed between the thumb nails. Contents still slightly viscid. Straw still a little green.

X. (28, 29, 30) Wheat fit to cut at beginning of this period. Straw has lost all its green color and is dark purple immediately below the heads. Berry nearly dry. May be crushed between the thumb nails but without contents adhering to them.

XI. (31, 32, 33) More than ripe. Straw bright and stands up well.

XII. (34, 35, 36) More than ripe. Straw bright and stands up well.

XIII. (37, 38, 39) More than ripe. Straw bright and stands up well.

XIV. (40, 41, 42) More than ripe. Straw bright and stands up well.

This wheat is of the variety known as the Fulcaster. It is a red, bearded wheat which has been grown quite extensively in this section.

THE PROTEIDS OF WHEAT.

A considerable portion of Bulletin No. 42, of this Station, was devoted to a discussion of investigations carried on for the purpose of formulating a ready quantitative method for separating the various proteids of the wheat grain. It was pointed out that during these investigations it had become apparent to the writer that the proteid of wheat which Osborne & Voorhees had designated as a proteose was really a quantity of gliadin, which had become dissolved in the 10 per cent salt solution which they used and had been collected by them after dialyzing away the salt and removing the edestin and leucosin. The chief reasons given for this belief may be briefly stated as follows: A considerable number of extracts of wheat and mill products of wheat were made under like conditions with a 1 per cent solution of common salt, and equal quantities of each were mixed with sufficient strong alcohol to make mixtures containing about 75 per cent of alcohol. After filtering off the proteids precipitated by the addition of the alcohol the liquid still contained in solution a considerable quantity of proteids, the amounts of which were found to be practically the same for the considerable number of samples of which the extracts had been made. These samples covered a wide range of material in which there were marked variations in the proportions of all other proteids present. The constancy of the quantity of alcohol-soluble proteid in the salt solution indicated that the salt solution had taken up as much of this compound as it was able to take into solution under those special conditions and that the compound dissolved existed in the material extracted in still larger quantities. Investigation showed that gliadin is very appreciably soluble in a 1 per cent solution and slightly soluble in a 10 per cent solution of common salt. Gliadin was also found to have the distinguishing reactions of a proteose and the general characteristics of the proteid which remains in solution after mixing alcohol with the salt extract as described.

An article setting forth the above facts was prepared and published in the American Chemical Journal.[1] A subsequent issue[2] of that journal contained a note by Dr. Osborne in which he stated that the work done was based upon wrong assumptions, and that the conclusion was decidedly in error.

The truth or falseness of the conclusion that this so-called "Proteose" is gliadin is important in considering the methods of analysis used in the separation of the proteids of the wheat grain in the experiments hereafter reported. For that reason further proof that the conclusion is correct is offered in this place.

In the note of Dr. Osborne, mentioned above, he stated that the distinguishing characteristics between the proteose and the gliadin had been given by him in his original paper. A reference to the reprint of that paper shows the following sentence (p. 13): "The identity (of the alcohol-soluble proteid of wheat) with the two albumens is excluded by the fact that they are precipitated by heat, and with the proteose by the fact that the alcohol-soluble proteid gives a precipitate with hydrochloric acid when dissolved in distilled water and also with a trace of sodium chloride, which the proteose does not."

It has been shown that gliadin is slightly soluble in a 10 per cent solution of common salt and appreciably more so in salt solutions of less strength. It appears therefore that the producing of a precipitate "with a trace of sodium chloride" will depend upon the amount and concentration of the proteid solution. It has been repeatedly demonstrated by experiments in this laboratory that dilute solutions of gliadin in distilled water often require at the ordinary temperature of the laboratory the addition of comparatively considerable quantities of concentrated sodium chloride solution to produce a precipitate or cloudiness of the proteid solution. Dilute solutions of gliadin in water which contained sufficient of that proteid to give very appreciable precipitates with other reagents showed no precipitate or cloud with hydrochloric acid, showing that the compound which is formed is appreciably soluble in distilled water. If now a quantity of gliadin be brought into solution in distilled water in the most ready way, which is by adding a little strong solution of the proteid in alcohol to a considerable bulk of water, and filtering, the few per cent of alcohol present will assist materially in increasing the solubility of the gliadin. If to a small quantity of solution thus prepared a little hydrochloric acid or salt solution be added, avoiding an excess, a beautiful white precipitate appears, which completely disappears with equal readiness and beauty upon the addition of a little distilled water. With careful manipulation alternate additions of a little salt, or hydrochloric acid, and distilled water will produce repeated appearance and disappearance of the precipitate. It follows from the proteose nature of gliadin that the solubility of the precipitates with sodium chloride or with hydrochloric acid will depend very materially upon the temperature. It appears from these facts that this supposed difference between the "Proteose" and the gliadin is not in itself sufficient to distinguish between the substances.

---

[1] Vol. XIX., No. 1, p. 65.
[2] Vol. XIX., No. 3, p. 236.

Again: Dr. Osborne states in his note that the proteids extracted by the 10 per cent salt solution which they employed were precipitated by saturating the solutions with solid ammonium sulphate, which would render gliadin insoluble in the 10 per cent salt solutions in which the proteids were subsequently dissolved.

A quantity of gliadin was brought into solution in distilled water and precipitated therefrom by saturating the solution with solid ammonium sulphate. The precipitate was collected on a filter and freed as far as possible from ammonium sulphate. It was then again dissolved in distilled water and was still found to possess the original characteristics of gliadin even to the extent of being somewhat soluble in cold dilute solutions of common salt up to and including 10 per cent. This gliadin was extracted from whole wheat meal by the use of strong alcohol, and any admixture of another proteose with it is highly improbable. The condition of the precipitation of the proteids by Osborne & Voorhees with solid ammonium sulphate were such that we would expect any precipitated gliadin to be thoroughly distributed throughout a mass of other readily soluble proteids and thus to be in the best possible condition to be brought into solution.

An examination of the original paper of Osborne & Voorhees will show that the analysis which they give as representing the composition of the coagulum of the "Proteose" was made upon a preparation* obtained without the use of ammonium sulphate, and that the results of that analysis do not furnish evidence of a compound having a composition markedly different from gliadin.

If, as Dr. Osborne states, 74 per cent alcohol does not precipitate the special proteose which he thinks will be present in the salt extracts, how are we to reconcile the following statement in their original paper? "We are therefore forced to conclude that in the wheat kernel only one proteid soluble in dilute alcohol exists, and that this is one of the constituents of the gluten."† The solvent which they used contained less than 60 per cent of alcohol.

The discussion may be summed up as follows: The properties of gliadin are such that we would expect to find, in the very situation in which they found their "Proteose," small quantities of a body having proteose reactions, and that no distinguishing characteristic or reactions between that "Proteose" and gliadin is known.

The proteids of wheat are, then, four: Edestin, Leucosin, Gliadin, Glutenin. Of these edestin and leucosin are readily soluble in dilute solutions of common salt, but are insoluble in dilute alcohol; gliadin is slightly soluble in dilute salt solutions and is readily soluble in hot dilute alcohol, while glutenin is insoluble in both of these liquids. The other compounds of the wheat grain which contain nitrogen are amides and lecithin. The nitrogen in amides may be considerable but that in lecithin amounts to no more than a mere trace. The amides are soluble in dilute salt solutions and in dilute alcohol. They are not precipitated from solution by phospho-tungstic acid while the proteids are. The amounts of nitrogen in wheat and in extracts of wheat made with various solvents can be determined by the Kjeldahl method with facility and with great accuracy. We have then means at our disposal for separating the nitrogen compounds of wheat which may be applied to an extensive series of experiments such as has been carried out in this laboratory, and is reported on the following pages. Details of this method has been given in Bulletin No. 42. They are more briefly outlined below, and a change in the strength of the alcohol used is explained.

---

* "Preparation 7."

† Amer. Chem. Jour., Vol. XV., p. 441.

Total nitrogen was determined in one gram of material. The Gunning modification of the Kjeldahl method was used in all nitrogen determinations.

Edestin and *leucosin nitrogen* were determined together by precipitating them from a 1 per cent sodium chloride solution extract of the fine ground material by adding to a measured quantity of the extract sufficient strong alcohol to make a mixture containing 75 per cent of alcohol. To this end 50 c. c. of clear salt solution extract, corresponding to one gram of substance, was mixed in a Kjeldahl flask with 250 c. c. of 188 per cent proof alcohol redistilled. After standing over night the precipitate was filtered off and the nitrogen in it determined.

Amide nitrogen was determined by precipitating all the proteids from 100 c. c. of the salt solution by use of phospho-tungstic acid. After standing over night the precipitated proteids were filtered off and the nitrogen of the amides in the resulting clear solution was determined.

To determine the *gliadin nitrogen* one gram of the fine material was completely extracted with hot alcohol of the specific gravity .90. The filtrate and washings were evaporated to dryness in a Kjeldahl flask and the nitrogen of the residue determined. The per cent of nitrogen found less the per cent of amide nitrogen in the sample gives the per cent of gliadin nitrogen.

The *glutenin nitrogen* is the difference between the per cent of the total nitrogen and the per cents of the nitrogen of edestin, leucosin, gliadin and amides.

The per cents of proteids in the material may be found by multiplying the corresponding nitrogen by 5.7.

In Bulletin No. 42 it was proposed to use 75 per cent alcohol for extracting the gliadin. It had been found that after extracting the meal in the usual way with this solvent no more proteid could be obtained. However, it was found later that 60 per cent alcohol used in the same way yielded more nitrogen than 75 per cent alcohol and a series of analyses was started for the purpose of finding the cause. Extracts were made on the same wheat meal with alcohols ranging from 40 to 95 per cent in strength, there being a difference of 5 per cent of alcohol between each solvent and the next stronger. The results were as given, the nitrogen in the extracts being computed to per cent on the one gram of wheat used.

Strength of Alcohol in Per Cent.	Per Cent Nitrogen in Extract.	Strength of Alcohol in Per Cent.	Per Cent Nitrogen in Extract.
95	.21	65	1.30
90	.31	60	1.38
85	.61	55	1.40
80	.89	50	1.40
75	1.08	45	1.40
70	1.18	40	1.40

It was found that treatment with 95 per cent alcohol almost completely prevented the dissolving of more proteid with 75 per cent alcohol. When 55 per cent or a weaker alcohol were used filtration proceeded with increased slowness, probably because of the increased gelatinization of starch. Accordingly alcohol of the specific gravity of .90 has been adopted for this solvent. In the case of flours, filtration with this strength of alcohol has been found to be almost impossible. In such instances a cold alcohol extract has been made by digesting five grams of the material with the alcohol in a 250 c. c. measuring flask for 24 or 48 hours, shaking at intervals. This material being finely ground the method is less objectionable than for the whole wheat meal where the danger of incomplete extraction is greater. However, the danger of loss in filtering and in taking an aliquot part of an alcohol extract is much greater than in case of a water solution and the method of the complete extraction of one gram is preferred where it can be used.

To facilitate the evaporation of the solvent preparatory to digesting the extract with acid a galvanized iron box of suitable form and size to receive eighteen Kjeldahl flasks (500 c. c.) has been procured. The flasks are placed in this box in an upright position so that the tip of the neck of each protrudes slightly through a hole in the cover. Steam at full heat is then passed into the box until the liquid in the flasks has been vaporized. This has been found to be convenient and effectual.

In the work on nitrogen for these inquiries all determinations were made in duplicate, and where the difference was .05 per cent or more the determinations were repeated until satisfactory. In the usual run of work the difference between duplicates was generally not more than .02 per cent. More frequently it was less. It is therefore believed that variations must be attributed to other causes than errors of determination.

Using the methods of analysis here outlined a determination has been made of the nitrogen compounds in the samples of wheat cut on each of the forty-two consecutive days of the harvest and ripened on the straw. The nitrogen has been determined in the grain of the heads cut from the straw for the first thirty-six days of the harvest and a complete determination of the nitrogen compounds of each third sample of this series of the experiment has been made. The results of these analyses are tabulated in detail. They show some painful irregularities which are evidently due to variations in the soil upon which the wheat grew. A new set of samples has been collected this year from other ground and a repetition and probable extension of the work is in progress. For this and other reasons the results are submitted for the most part without comment.

TABLE SHOWING TOTAL NITROGEN AND NITROGEN OF DIFFERENT COMPOUNDS, IN PER CENT OF THE TOTAL DRY MATTER OF WHEAT GATHERED ON EACH OF FORTY-TWO CONSECUTIVE DAYS FROM THE TIME OF THE SETTING OF THE GRAIN AND RIPENED ON THE STRAW.

No. of Cutting.	Total Nitrogen.	Gliadin Nitrogen.	Glutenin Nitrogen.	Edestin and Leucosin Nitrogen.	Amide Nitrogen.
1	3.83	.98	1.74	.44	.67
2	3.64	1.08	1.57	.44	.55
3	3.58	1.07	1.57	.44	.50
4	3.46	1.11	1.54	.44	.37
5	3.25	1.13	1.43	.43	.26
6	3.03	1.13	1.24	.45	.21
7	3.11	1.22	1.19	.47	.23
8	2.77	1.09	1.01	.46	.21
9	2.66	1.09	.99	.40	.18
10	2.66	1.11	.96	.40	.19
11	2.65	1.12	.96	.39	.18
12	2.57	1.08	.93	.40	.16
13	2.66	1.13	.95	.40	.18
14	2.51	1.04	.92	.39	.16
15	2.47	1.14	.86	.34	.13
16	2.35	1.09	.83	.31	.12
17	2.41	1.08	.88	.34	.11
18	2.32	1.06	.82	.33	.11
19	2.48	1.19	.88	.31	.10
20	2.36	1.13	.85	.26	.12
21	2.52	1.25	.91	.27	.09
22	2.46	1.21	.88	.28	.09
23	2.72	1.35	.98	.28	.11
24	2.88	1.48	1.03	.27	.10
25	2.77	1.43	.99	.26	.09
26	2.62	1.45	.77	.30	.10
27	2.94	1.60	.94	.31	.09
28	2.91	1.56	.90	.35	.10
29	2.80	1.47	.90	.33	.10
30	3.13	1.70	.99	.35	.09
31	2.77	1.46	.88	.34	.09
32	3.05	1.62	1.01	.33	.09
33	2.31	1.16	.80	.27	.08

No. of Cutting.	Total Nitrogen.	Gliadin Nitrogen.	Glutenin Nitrogen.	Edestin and Leucosin Nitrogen.	Amide Nitrogen.
34	3.07	1.65	.94	.37	.11
35	2.97	1.62	.89	.35	.11
36	3.01	1.57	1.00	.32	.12
37	3.23	1.69	1.08	.32	.13
38	3.04	1.64	.94	.35	.11
39	2.82	1.44	.91	.34	.13
40	3.27	1.74	1.04	.37	.12
41	3.23	1.74	1.02	.34	.13
42	3.02	1.57	.98	.36	.11

TABLE SHOWING TOTAL NITROGEN AND NITROGEN OF DIFFERENT COMPOUNDS. IN PER CENT OF THE TOTAL DRY MATTER FROM HEADS CUT FROM STRAW ON EACH THIRD DAY OF THIRTY-SIX CONSECUTIVE DAYS FROM THE TIME OF THE SETTING OF THE GRAIN.

No. of Cutting.	Total Nitrogen.	Gliadin Nitrogen.	Glutenin Nitrogen.	Edestin and Leucosin Nitrogen.	Amide Nitrogen.
1	3.82	1.06	1.55	.47	.74
3	3.88	1.17	1.62	.48	.61
6	3.49	1.33	1.30	.51	.35
9	3.27	1.32	1.18	.47	.30
12	2.76	1.19	.96	.41	.20
15	2.71	1.32	.94	.32	.13
18	2.48	1.13	.89	.34	.12
21	2.81	1.39	1.00	.31	.11
24	2.91	1.52	1.00	.30	.09
27	2.94	1.60	.94	.33	.07
30	3.09	1.64	1.02	.34	.09
33	2.25	1.19	.73	.26	.07
36	3.17	1.68	1.06	.33	.10

TABLE SHOWING THE DIFFERENCE BETWEEN THE PER CENT OF TOTAL NITROGEN OF THE DRY MATTER OF WHEAT RIPENED ON THE STRAW AND THAT OF HEADS CUT FROM THE STRAW FOR EACH OF THIRTY-SIX CONSECUTIVE DAYS FROM THE TIME OF THE SETTING OF THE GRAIN.

No. of Cutting.	Straw Series.	Head Series.	Difference.	No. of Cutting.	Straw Series.	Head Series.	Difference.
1	3.83	3.82	.01	19	2.48	2.62	.14
2	3.64	3.84	.20	20	2.36	2.48	.12
3	3.58	3.88	.30	21	2.52	2.81	.29
4	3.46	3.88	.42	22	2.46	2.45	—.01*
5	3.25	3.49	.24	23	2.72	2.84	.12
6	3.03	3.49	.46	24	2.88	2.91	.03
7	3.11	3.15	.04	25	2.77	2.73	—.04
8	2.77	3.18	.41	26	2.62	2.59	—.03
9	2.66	3.27	.61	27	2.94	2.94	.00
10	2.66	2.95	.29	28	2.91	3.05	.14
11	2.65	2.99	.34	29	2.80	2.70	—.10
12	2.57	2.76	.19	30	3.13	3.09	—.04
13	2.66	2.72	.06	31	2.77	2.82	—.05
14	2.51	2.77	.26	32	3.05	3.21	.17
15	2.47	2.71	.24	33	2.31	2.25	—.06
16	2.35	2.41	.06	34	3.07	3.16	.09
17	2.41	2.46	.05	35	2.97	3.01	.04
18	2.32	2.48	.16	36	3.01	3.17	.16

TABLE SHOWING, FOR GROUPS OF THREE DAYS EACH, THE AVERAGE PER CENT OF TOTAL NITROGEN OF THE DRY MATTER OF WHEAT RIPENED ON THE STRAW, AND OF WHEAT OF HEADS CUT FROM THE STRAW AND THE DIFFERENCE BETWEEN THESE AVERAGES.

No. of Group.	Straw Series.	Head Series.	Difference.
I.	3.68	3.85	.17
II.	3.25	3.63	.38
III.	2.85	3.20	.35
IV.	2.63	2.90	.27
V.	2.35	2.73	.28
VI.	2.36	2.45	.09
VII.	2.45	2.64	.19
VIII.	2.69	2.73	.04

---

*Differences preceded by minus sign indicate nitrogen in straw series greater than in head series.

No. of Group.	Straw Series.	Head Series.	Difference.
IX.	2.78	2.75	—.03
.X.	2.95	2.95	.00
XI.	2.71	2.76	.05
(XI.)*	(2.91)	(3.01)	(.10)
XII.	3.02	3.11	.09
XIII.	3.03		
XIV.	3.17		

TABLE SHOWING, FOR WHEAT OF HEADS CUT FROM STRAW, THE NITROGEN OF DIFFERENT COMPOUNDS IN PER CENT OF THE TOTAL NITROGEN FOUND.

No. of Cutting.	Gliadin Nitrogen.	Glutenin Nitrogen.	Edestin and Leucosin Nitrogen.	Amide Nitrogen.
1	27.3	40.9	12.4	19.4
3	30.2	41.7	12.3	15.8
6	38.0	37.4	14.7	9.9
9	40.4	36.0	14.4	9.2
12	42.9	34.8	15.0	7.3
15	48.6	34.6	11.9	4.9
18	45.5	36.0	13.5	5.0
21	49.4	35.8	10.8	4.0
24	52.1	34.4	10.4	3.1
27	54.4	32.0	11.2	2.4
30	53.1	33.0	11.0	2.9
33	53.1	32.3	11.6	3.0
36	52.9	33.6	10.3	3.2

TABLE SHOWING, IN PER CENT OF THE TOTAL NITROGEN FOUND, THE NITROGEN OF THE DIFFERENT COMPOUNDS IN WHEAT OF THE SERIES RIPENED ON STRAW.

No. of Cutting.	Gliadin Nitrogen.	Glutenin Nitrogen.	Edestin and Leucosin Nitrogen.	Amide Nitrogen.
1	25.7	45.4	11.5	17.4
2	29.7	43.0	12.1	15.2
3	29.9	44.0	12.3	13.8
4	32.1	44.5	12.7	10.7
5	34.7	44.0	13.4	7.9
6	37.4	40.7	14.9	7.0

---

*Figures in parenthesis give average in group XI, omitting No. 33 (see p. 56).

No. of Cutting.	Gliadin Nitrogen.	Glutenin Nitrogen.	Edestin and Leucosin Nitrogen.	Amide Nitrogen.
7	39.4	38.4	15.0	7.2
8	39.3	37.6	15.4	7.7
9	40.9	37.4	14.9	6.8
10	41.5	36.0	15.3	7.2
11	42.1	36.2	14.9	6.8
12	42.0	36.3	15.5	6.2
13	42.5	35.6	15.0	6.9
14	41.4	36.8	15.4	6.4
15	46.1	34.7	13.7	5.5
16	46.2	35.1	13.4	5.3
17	44.9	36.4	14.0	4.7
18	45.7	35.4	14.2	4.7
19	48.2	35.3	12.4	4.1
20	47.8	35.8	11.1	5.3
21	49.3	36.3	10.8	3.6
22	49.5	35.8	11.0	3.7
23	49.6	35.8	10.4	4.2
24	51.0	36.1	9.4	3.5
25	51.6	35.8	9.3	3.3
26	54.8	30.0	11.3	3.9
27	54.2	32.2	10.5	3.1
28	53.3	31.0	12.2	3.5
29	52.4	32.0	11.9	3.7
30	54.2	31.6	11.3	2.9
31	52.7	31.8	12.1	3.3
32	53.1	33.1	10.8	3.0
33	50.0	34.6	11.9	3.5
34	53.8	30.6	11.9	3.7
35	54.6	29.8	11.8	3.8
36	52.3	33.0	10.6	4.1
37	52.1	33.6	10.0	4.3
38	53.8	31.1	11.3	3.8
39	51.2	32.4	11.9	4.5
40	53.4	31.7	11.4	3.5
41	53.9	31.7	10.4	4.0
42	51.9	32.4	11.9	3.8

TABLE SHOWING THE AVERAGE OF THE NITROGEN OF DIFFERENT NITROGEN COMPOUNDS FOR PERIODS OF THREE DAYS EACH IN PER CENT OF THE AVERAGE TOTAL NITROGEN OF EACH GROUP FOR WHEAT OF THE SERIES RIPENED ON STRAW.

No. of Period.	Gliadin Nitrogen.	Glutenin Nitrogen.	Edestin and Leucosin Nitrogen.	Amide Nitro-nitrogen.
I.	28.4	44.2	11.9	15.5
II.	34.7	43.1	13.7	8.5
III.	39.9	37.8	15.1	7.2
IV.	41.9	36.2	15.2	6.7
V.	43.3	35.7	14.7	6.3
VI.	45.6	35.6	13.9	4.9
VII.	48.5	35.8	11.4	4.3
VIII.	50.0	35.9	10.3	3.8
IX.	53.5	32.7	10.4	3.4
X.	53.3	31.5	11.8	3.4
XI.	51.9	33.2	11.6	3.3
(XI.)*	(52.9)	(32.4)	(11.5)	(3.2)
XII.	53.5	31.1	11.5	3.9
XIII.	52.4	32.3	11.1	4.2
XIV.	53.0	31.9	11.3	3.8

GLUTEN.

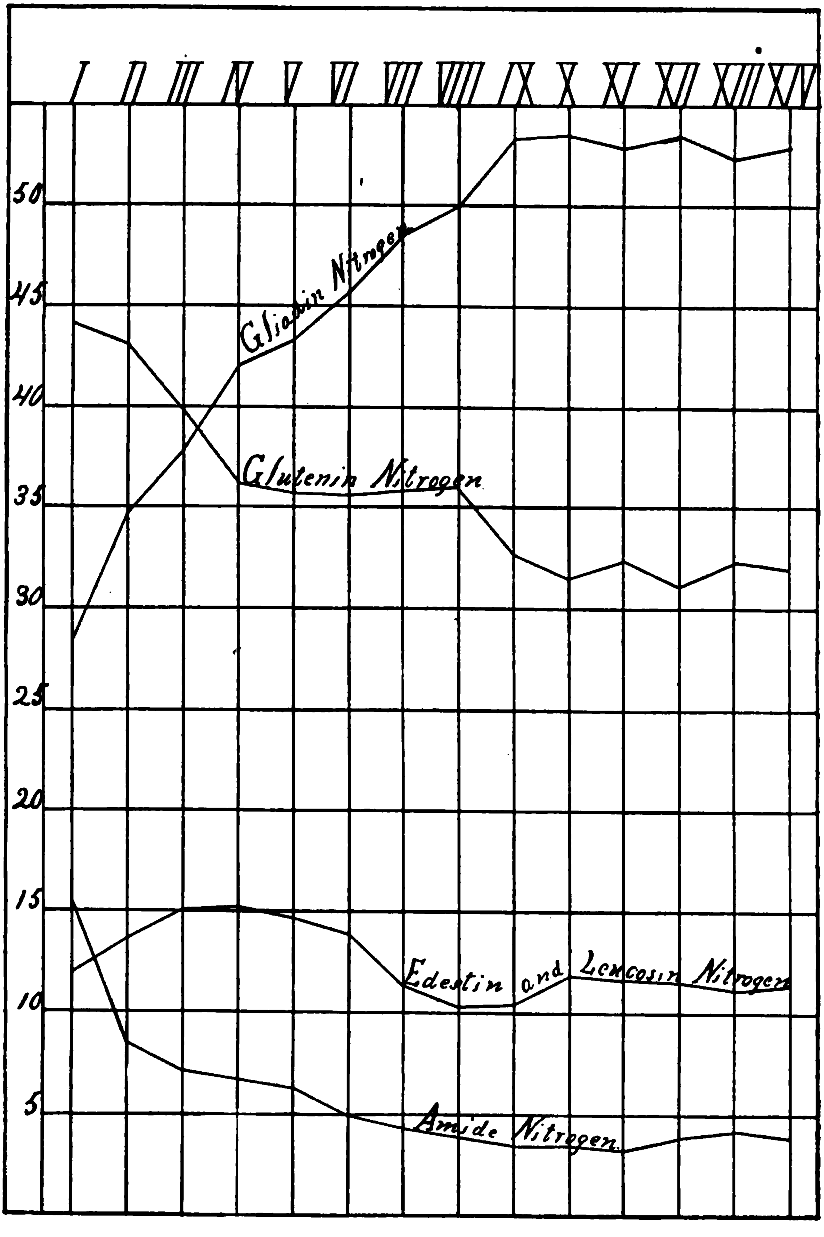
One of the most important indexes as to the quality of a wheat flour is the amount and kind of gluten which it contains. This substance consists of the two proteids,. gliadin and glutenin. The glutens of different flours differ greatly in quality and consistency as well as in amounts. It has been found by different experimenters that glutens of different consistency have different proportions of gliadin and glutenin, but a definite knowledge as to the relation between the proportions of these proteids and the consistency of the gluten does not seem to have yet been acquired. It is a problem the solution of which will require extensive and thorough investigation on a great variety of material.

---

*Figures in parenthesis give average of group XI, omitting No. 33.

NITROGEN OF DIFFERENT COMPOUNDS IN PER CENT OF TOTAL NITROGEN IN WHEAT KERNELS FOR GROUPS OF DAILY CUTTINGS. BEFORE, DURING AND AFTER RIPENING.

(See pages 57 and 70).



ENDOSPERM OF THE WHEAT.

Considered from the standpoint of the miller, the wheat grain consists of three principal parts: The germ, the bran, and the endosperm. In producing flour the whole of the germ and the greater part of the bran are eliminated from the finished product. The purest patent flour consists entirely of endosperm. The flours of lower grade than the patent consist of ground endosperm mixed with more or less fine bran particles. Generally speaking, the more bran particles there are the lower the grade of the flour.

It is the effort of the miller to obtain the largest possible amounts of the highest possible grades of flour. In other words, he endeavors to obtain the largest possible amount of endosperm in such a way that it shall be as free as possible from bran particles. To save portions of the endosperm which he would otherwise lose after making his best flours, he allows the admixing of greater portions of bran and makes his low grades of flour.

The bran of the wheat grain contains a considerable larger proportion than does the endosperm of each of the following constituents: Ash, proteids, fats, fiber. It therefore follows that the greater the proportions of bran mixed with the endosperm the greater will be the proportion of these constituents in the resulting flour. The proportions of the different kinds of proteids will also be changed by the presence of the bran.

Since the relative proportions and the relative composition of the bran and the endosperm of wheats differ, it is necessary, in considering the chemical composition of flours which a wheat will produce, to have other data than the chemical composition of the entire wheat grain. If we attempt to convert our samples of wheat into flour and examine it, we are met with the fact that the amount of flour and of the different grades of flour which a wheat will produce depends upon the mill, the skill of the miller and the quality and condition of the wheat.

To compare samples of wheat by a chemical analysis of flours produced from them it would be necessary to produce flours which shall consist of constant and proper admixtures of bran and endosperm, mixtures which might be duplicated at will, and, if possible, such as will be produced by mills that are to use the wheat. There are obstacles in this which it would be exceedingly difficult to overcome, so difficult that for the work in hand it seems impracticable. It is however possible, at least with hard wheat such as has been used in this experiment, to separate a quantity of endosperm from all bran particles. So far as is known there is no reason for believing that one portion of the endosperm of a wheat kernel is different from any other portion. Inasmuch as it is the endosperm which constitutes so large a proportion of the flour produced from wheat, and since the bran particles of flour are only accidentally present and in ever varying quantities, it would seem that we have in the pure endosperm a constant positive factor for comparing the qualities of flours which different wheats will produce. Accordingly, in comparing the wheat cut on different days, endosperm of a portion of the samples has been separated out and submitted to partial analysis.

For separating the endosperm in these experiments, rollers, such as are usually found in roller flouring mills, were used. An effort was made to have a small roller mill constructed somewhat after the plan of that used by Guthrie & Gurney, in New South Wales, Australia. It was found that such a mill, requiring as it would special patterns for its castings, would be more costly than the large roller machines of ordinary construction. A new mill of the smallest size made was purchased of the manufacturers at a moderate price. This mill contains two pairs of rolls, each 12 inches long by 6 inches in diameter. One pair is smooth, the other is corrugated. Of the several varieties of such mills which are manufactured, one was chosen which, from the general plan of its construction, seemed most likely to answer the purpose for which it was to be adapted.

It was planned to use from one-half to 2 pounds of grain for each sample milled. To provide for a more constant action on such small samples, the grinding surface for each pair of rolls was reduced to the middle 4 inches by inserting within the usual frame work suitable small hoppers and end blocks. With the help of a good carpenter this was easily done. A support for the receiving basin was fixed at a suitable distance below each pair of rolls. The products of each grinding can thus be readily collected in a tin basin of a few pints' capacity. The mill has been run by a small gasoline engine which has also been used for other grinding and for threshing.

The products from the various breaks and reductions of the wheat and its parts were separated by hand sieves 10 inches in diameter, and carrying bolting cloths, each of a different grade. The grades of bolting cloth mostly used have been Nos. 000, 2, 8, and 11. It has been found that with the proper use of this mill and these sieves the pure endosperm can be obtained from such wheat as has been used in this series of experiments with considerable facility. The effort has been to obtain quality and not quantity.

The partial analyses of the flour which has been obtained have, for this year's work, been confined to the nitrogen compounds and the necessary moisture determinations. Only samples of the series ripened on the straw were ground in this mill.

TABLE SHOWING, IN PER CENT OF THE TOTAL DRY MATTER, THE NITROGEN OF THE DIFFERENT NITROGEN COMPOUNDS OF THE ENDOSPERM OF WHEAT CUT ON DIFFERENT DAYS.

No. of Cutting.	Total Nitrogen.	Gliadin Nitrogen.	Glutenin Nitrogen.	Edestin and Leucosin Nitrogen.	Amide Nitrogen.
16	2.02	1.21	.59	.20	.02
17	2.05	1.20	.64	.19	.02
18	2.00	1.15	.64	.19	.02
19	2.12	1.20	.71	.19	.02
20	2.02	1.15	.68	.17	.02
21	2.10	1.26	.65	.17	.02
22	2.00	1.20	.61	.17	.02
23	2.19	1.31	.68	.18	.02
24	2.36	1.43	.72	.19	.02
25	2.22	1.34	.68	.18	.02
26	2.11	1.27	.66	.16	.02
27	2.30	1.37	.72	.19	.02
28	2.35	1.46	.69	.18	.02
29	2.16	1.33	.63	.18	.02
30	2.41	1.45	.77	.17	.02

TABLE SHOWING, IN PER CENT OF THE TOTAL NITROGEN PRESENT, THE NITROGEN OF DIFFERENT COMPOUNDS IN THE ENDOSPERM OF WHEAT CUT ON DIFFERENT DAYS.

No. of Cutting.	Gliadin Nitrogen.	Glutenin Nitrogen.	Edestin and Leucosin Nitrogen.	Amide Nitrogen.
16	59.9	29.2	9.9	1.0
17	58.5	31.2	9.3	1.0
18	57.5	32.0	9.5	1.0
19	56.6	33.5	9.0	.9
20	56.9	33.7	8.4	1.0
21	60.0	30.9	8.1	1.0
22	60.0	30.5	8.5	1.0
23	59 8	31.1	8.2	.9

No. of Cutting.	Gliadin Nitrogen.	Glutenin Nitrogen.	Edestin and Leucosin Nitrogen.	Amide Nitrogen.
24	60.6	30.5	8.0	.9
25	60.4	30.6	8.1	.9
26	60.2	31.2	7.6	1.0
27	59.6	31.3	8.2	.9
28	62.1	29.4	7.6	.9
29	61.6	29.2	8.3	.9
30	60.2	32.0	7.0	.8

TABLE COMPARING THE PER CENTS OF TOTAL NITROGEN AND ALSO THE PER CENTS OF GLIADIN NITROGEN IN THE DRY MATTER OF THE WHOLE WHEAT AND OF THE ENDOSPERM OF SAMPLES CUT ON DIFFERENT DAYS.

No. of Cutting.	Total Nitrogen.			Gliadin Nitrogen.		
	Wheat.	Endosperm.	Difference.	Wheat.	Endosperm.	Difference.
16	2.35	2.02	.33	1.09	1.21	—.12*
17	2.41	2.05	.36	1.08	1.20	—.12
18	2.32	2.00	.32	1.06	1.15	—.09
19	2.48	2.12	.36	1.19	1.20	—.01
20	2.36	2.02	.34	1.13	1.15	—.02
21	2.52	2.10	.42	1.25	1.26	—.01
22	2.46	2.00	.46	1.21	1.20	.01
23	2.72	2.19	.53	1.35	1.31	.04
24	2.88	2.36	.52	1.48	1.43	.05
25	2.77	2.22	.55	1.43	1.34	.09
26	2.62	2.11	.51	1.45	1.27	.18
27	2.94	2.30	.64	1.60	1.37	.23
28	2.91	2.35	.56	1.56	1.46	.10
29	2.80	2.16	.64	1.47	1.33	.14
30	3.13	2.41	.72	1.70	1.45	.25

---

*Minus differences indicate the per cent of gliadin nitrogen in the endosperm greater than in the whole wheat.

PROXIMATE COMPOSITION OF THE WHEAT.

To obtain data as to the proximate composition of the wheat at different times during the period of cutting, the forty-two samples ripened on the straw were divided into fourteen lots of three samples each, corresponding to the fourteen groups which have been already indicated. Equal weights of the three samples of each group were mixed together and a portion of each mixed sample was ground and submitted to analysis. In addition to the determinations usually made in the analysis of foods, an effort was made to separate the carbohydrate group of each sample into its components. The substances of this group of which determinations were made are: Sucrose, dextrose (or reducing sugars), dextrins (and allied compounds), pentosans and starch. The plan of analysis which was adopted is as follows:

Pentosans. These were estimated by the official[1] method, precipitating the furfural with phloroglucin and computing the results as xylan.[2]

Sugars. To determine the sugars, two grams of meal were extracted with hot, strong alcohol. This was distilled off and the sugar extracted from the residue with water. In the solution thus obtained the *reducing sugar* was determined by Allihn's method. In another similar extract the *total sugar* was determined by inverting the sucrose in the water solution with hydrochloric acid, neutralizing the acid with sodium carbonate and then proceeding as before. The difference in the reducing power of the extract before and after inverting gave figures for computing the *sucrose*.

Starch. The hot alcohol extracts not only the sugars, but also the greater part of the fat. The residue is therefore in a suitable condition for determining the starch by the diastase method. This method was carried out according to details adopted by the Association of Official Agricultural Chemists at their last meeting, except that instead of boiling the acidified solution for two and one-half hours, the flasks containing the liquid were immersed in a steam bath for three hours. The temperature in this bath was very nearly that of boiling water, and the method has been found convenient and satisfactory. The resulting sugar was determined by Allihn's method. The results include starch and dextrins. The dextrins being determined, the starch is found by difference.

Dextrins. It was found that extracting the meal with hot 92 per cent alcohol converts a portion of the starch into a form soluble in cold water and a separation of the dextrin from this portion of material is impracticable. Accordingly, to determine the dextrins, five grams of the fresh material were thoroughly digested in a 250 c. c. flask with cold water; 200 c. c. of this clear filtered extract were treated with hydrochloric acid in the steam bath in the same manner as the diastased starch solutions. The reducing power of the resulting solution is due to sugars and dextrins. The reducing power of the sugar having been determined, the dextrin compounds are computed from the difference.

---

[1] Circular No. 4, Div. of Chem. U. S. Dept. of Agriculture.

[2] Journal Am. Chem. Society, Vol. XIX., No. 3, p. 189.

In the tabulated results which are given, the starch is found by difference.

While the results of actual determinations of starch which have been made make the sum of all parts found approximate remarkably close to 100 per cent over the latter two-thirds of the series, and fall short on the remaining third in a manner which shows a special cause, the method of starch determination is still under investigation, and the results obtained do not seem to be worthy of the same confidence as those for other compounds. They are therefore withheld.

Noteworthy among the results of this series of analysis is the considerable falling off in the proportions of ash, amides, fats, fiber, dextrins, and pentosans from the first period up to the time of the ripening of the grain; the rapid decrease and almost total disappearance of reducing sugars over that time; the decrease of sucrose and the increase of starch over the early periods. The starch decreases somewhat over the later periods, probably because of the increase of proteids.

Standing out in marked contrast with the results obtained by Dr. Kedzie in his experiments in Michigan is the increase in the proportion of proteids in the dry matter of the wheat as it stood in the field after the usual time of harvesting. It must for the present be left as a matter of conjecture as to whether this is due to the difference in climate, the peculiarity of the special season, or to some other cause. Contrary to the usual experience in this climate the wheat was uninjured by remaining on the ground after the usual time of harvesting. The straw remained upright and bright as long as the cutting continued which was more than two weeks after the wheat was fully ripe. A comparison of the total nitrogen found in the whole wheat and in the endosperm as shown in the results of the milling experiment is suggestive in this connection. It is hoped that work now in progress will throw more light on this subject.

TABLE SHOWING THE PROXIMATE COMPOSITION OF WHEAT, IN PER CENT OF THE TOTAL DRY MATTER, AT FOURTEEN DIFFERENT PERIODS* OF THREE DAYS EACH FROM THE SETTING OF THE GRAIN TO PAST RIPENESS, THE WHEAT BEING GATHERED AND DRIED ON THE STRAW.

Groups.	I.	II.	III.	IV.	V.	VI.	VII.
Ash	4.81	4.16	3.24	2.52	2.16	2.07	1.82
Proteids	17.80	17.30	15.36	14.30	13.75	13.15	13.64
Amides	2.83	1.40	1.01	.91	.78	.56	.51
Fats	4.32	3.09	2.64	2.51	2.31	2.38	2.45
Crude Fiber	8.69	6.96	5.50	4.56	3.72	3.30	3.10
Pentosans	13.54	12.84	12.28	11.10	9.73	9.66	9.32
Dextrins	2.00	3.07	2.86	2.66	2.26	2.11	1.94
Sucrose	2.95	2.80	2.26	1.94	1.42	1.45	1.45
Dextrose	1.55	.64	.17	.08	.07	.05	.05
Starch and Undetermined	41.51	47.74	54.68	59.42	63.80	65.27	65.72

Groups.	VIII.	IX.	X.	XI.	XII.	XIII.	XIV.
Ash	1.80	1.68	1.79	1.77	1.59	1.87	1.67
Proteids	14.55	15.40	16.24	14.96	16.59	16.56	17.26
Amides	.50	.44	.50	.44	.61	.62	.56
Fats	2.59	2.60	2.44	2.50	2.37	2.46	2.52
Crude Fiber	3.11	3.01	3.03	3.04	2.98	3.00	2.96
Pentosans	8.82	8.50	8.41	8.08	8.16	8.33	8.63
Dextrins	1.75	1.72	1.83	2.46	1.77	1.79	1.75
Sucrose	1.43	1.28	1.44	1.52	1.51	1.53	1.50
Dextrose	Trace	.01	Trace	Trace	Trace	Trace	Trace
Starch and Undetermined	65.45	65.36	64.32	65.23	64.42	63.84	63.15

---

* The stage of development for each of these periods is indicated on page 57.

CONCLUSIONS.

It is believed that the following conclusions are justified from the results of the work as shown on the preceding pages. After each conclusion the number of the page bearing the data in support of it is given.

The proteid designated by Osborne & Voorhees as a "Proteose" is gliadin (pages 58-61).

When considered in proportion to the whole amount of nitrogen compounds present there is a large increase in the gliadin from the earliest cutting of the grain until it is ripened. There is a marked but smaller decrease in the proportion of glutenin over the same time and a very rapid falling off in the proportion of amides during the first few days. The changes in the proportion of edestin and leucosin during the entire time of cutting is less marked and more irregular (pages 68-71).

There is a corresponding but less marked change in these same compounds when considered in per cents of the dry matter of the grain (page 65).

The nitrogen compounds in this grain when ripe were in about the following proportions: Amides, 1; edestin and leucosin, 3.5; glutenin, 10, and gliadin, 16 (page 70).

There was over the period preceding ripening a very appreciable larger per cent of nitrogen in the wheat of heads cut from the straw at the time of the gathering than in that gathered at the same time and dried on the straw, the explanation of which seems to be that the transfer of dry matter from the straw to the grain after cutting was largely one of non-nitrogenous matter (page 67).

When considered in relation to the whole amount of nitrogen compounds present there was little difference in the proportions of the different nitrogen compounds in the wheat dried on the straw and in that of heads cut from the straw (page 68).

There is a very appreciable larger difference between the per cents of total nitrogen in the whole wheat and the total nitrogen in the endosperm from wheat cut when ripe than from that cut from a week to ten days earlier (page 75).

The per cents of gliadin nitrogen in the dry matter of the endosperm and in the dry matter of the whole grain gradually shifted their relative positions in wheat cut daily from nearly two weeks before ripening up to the time of ripening, being appreciably greater for the endosperm during the earlier days and appreciably greater for the whole wheat during the latter (page 75).

The proportions of ash, amides, fats, fiber, dextrins and pentosans gradually decreased in the dry matter of the grain from the earliest stages up to ripeness. The proportion of sucrose rapidly decreased for the first five periods and was practically constant from then on. The very appreciable quantity of reducing sugar in the earlier periods decreased to a mere trace up to the time of ripening. The proportion of starch rapidly increased up to a week or more before ripening (page 78).

The proportion of total proteids in the dry matter of the grain steadily decreased from the earliest time up to about a week before ripening and gradually increased from then on. This is not in accord with results of Dr. Kedzie in experiments of two different years in Michigan, and it is hoped that further information on the subject may be obtained from work now in progress on another year's growth of Arkansas wheat (page 78).

In carrying out the many and ofttimes arduous and very unpleasant details of these investigations and of the constructing and arranging of apparatus for them I have enjoyed the faithful coöperation of Mr. J. F. Moore.

G. L. TELLER.

WEATHER RECORD, 1897, DURING AND IMMEDIATELY BEFORE THE HARVESTING.

Day of Month.	April.				May.				June.			
	Temperature		Rain in Ins.	Kind of Day.	Temperature		Rain in Ins.	Kind of Day.	Temperature		Rain in Ins.	Kind of Day.
	Maximum.	Minimum.			Maximum.	Minimum			Maxi mum.	Minimum.		
1	70	41	......	Clear	72	38	....	Clear	84	56	....	Part cloudy.
2	75	40	....	Clear...........	72	42	T	Cloudy..	80	62	.80	Part cloudy.
3	74	49	.65	Part cloudy..	74	41	.... ..	Clear	76	58	.85	Cloudy.
4	70	45	....	Clear	82	43	....	Clear	75	47	.. ..	Clear.
5	68	42	.. ..	Clear	85	47	....	Clear	78	51	....	Clear.
6	65	43	T	Part cloudy...	85	56	....	Clear	68	56	.35	Cloudy.
7	69	43	....	Cloudy........	75	59	.09	Cloudy..	77	55	.05	Clear.
8	63	38	1.45	Cloudy........	70	58	....	Cloudy..	80	57	....	Part cloudy.
9	61	33	T	Clear	66	61	.15	Cloudy.......	81	57	....	Clear.
10	60	36	.02	Cloudy..	64	56	.05	Cloudy..	88	63	....	Clear.
11	64	33	. ...	Clear	67	57	.09	Cloudy.......	90	62	....	Clear.
12	67	51	.10	Cloudy..	80	53	....	Part cloudy..	87	66	.09	Part cloudy.
13	65	41	....	Part cloudy..	80	51	T	Part cloudy..	89	66	T	Cloudy.
14	62	40	.08	Clear	70	39	.02	Clear	87	64	1.15	Part cloudy.
15	70	41	....	Clear	79	47	....	Clear	86	66	.13	Cloudy.
16	64	38	. ...	Clear	82	50	....	Clear	87	62	....	Part cloudy.
17	71	34	....	Clear......	82	54	....	Part cloudy.	91	73	....	Clear.
18	79	44	....	Clear	84	52	....	Clear	90	72	....	Clear.
19	74	56	....	Clear	84	49	....	Clear	92	71	....	Clear.
20	74	51	. ...	Part cloudy..	85	54	....	Clear	94	66	....	Clear.
21	78	58	....	Part cloudy..	87	54	....	Part cloudy..	93	64	....	Clear.
22	77	63	....	Part cloudy..	86	61	....	Part cloudy..	95	76	....	Clear.
23	77	63	T	Cloudy.. .. .	86	61	....	Part cloudy..	89	74	T	Part cloudy.
24	74	63	.52	Cloudy..	78	48	....	Clear	90	74	....	Clear.
25	74	56	1.35	Part cloudy..	75	55	T	Cloudy..	85	62	.19	Part cloudy.
26	85	47	....	Clear	75	59	....	Clear	88	69	....	Part cloudy.
27	81	51	....	Part cloudy..	86	63	....	Part cloudy..	93	69	....	Part cloudy.
28	76	57	.39	Cloudy..	81	63	.25	Cloudy..	90	72	......	Part cloudy.
29	59	46	.04	Cloudy	65	59	.02	Cloudy.......	92	70	.. ..	Clear.
30	66	48	....	Clear	72	50	....	Clear..........	95	69	....	Clear.
31	... ...	.. ..	....	....	78	46	......	Clear	......	....	....	....
			4.60				.67				3.61	
M.	70.3	46.6			77.6	52.5			86.3	64.3		

FATTENING VALUE OF CERTAIN FOODS GATHERED BY PIGS.

By R. L. Bennett.

In the progress of experiments in the production of pork on foods gathered by hogs, a trial has been made of the relative fattening qualities of three foods that have proven excellent for fattening and well adapted in yield and otherwise for pigs to gather. The relative fattening value of corn with those foods was also ascertained—it being fed to pigs in a suitable pen. This report is of the first trial recently completed of those foods. The crops were Spanish peanuts, chufas, and soja beans planted at Newport, Ark., on sandy loam cotton soil that produces an average of 30 bushels of corn per acre. The cultivation of the crops was of the character and extent usually given to corn by cotton farmers. Planting was done in 3 foot rows, 14 inches in row for peanuts, 12 inches in row for chufas and continuous in row for soja beans. The stand secured of each was estimated to be 87 per cent of a perfect stand for peanuts, 75 per cent of chufas and a good stand for soja beans. A few days before the foods were ready for feeding fourteen half-breed Berkshire pigs, in thrifty condition and weighing an average of 124 pounds, were secured for the trial. The pigs were divided as equally as possible as to appearance, weight, etc., into four lots. Two lots of four pigs each, one lot of which was put on peanuts and the other on soja beans, and two lots of three pigs each, one lot of which was put on chufas and the other fed corn in a pen. On September 24 the pigs were confined with movable fence on small areas of each crop, and as the food was consumed on these areas the pigs were moved to fresh places. At the time feeding began the soja bean pods were all well filled and some were changing color, and as feeding progressed and the pods dried the pigs showed a preference for the green ones by eating them first. The pigs on corn were given all they would eat—it being fed dry on the ear. The feeding was continued on the peanuts and chufas for forty-six days, while the lot on soja beans was continued only thirty-two days, the area in beans being consumed sooner than was expected. That difference in time of feeding does not affect the final results, as the soja beans were clearly not equal in fattening or yield of food to the peanuts or chufas. Frequent rains caused the soil at times to adhere to the chufas and made it somewhat difficult for the pigs to eat them without eating much earth. There is no difficulty at any time in finding and separating Spanish peanuts from the soil. The pigs did their eating mainly at early morning and late evening.

Peanuts and chufas contain a very large per cent of fat and are grown extensively in some countries for making oil.

Following herewith are the gains of the pigs, the areas of each food consumed, the time in which they were consumed, and the yields of the different crops or foods:

Foods.	No. Pigs.	Weight at Beginning.	Weight, End of 32 Days.	Weight, End of 46 Days.	Gain in 32 Days.	Gain in 46 Days.	Area of Food Consumed.
Peanuts,	4	466	760	884	294	418	⅓ Acre.
Soja Beans	4	499	590		91		⅓ Acre.
Corn,	3	417	646	754	229	337	23 Bushels.
Chufas,	3	364	482	562	118	198	⅓ Acre.

AVERAGE WEIGHT AND GAINS PER PIG IN POUNDS.

Foods.	Weight at Beginning, Per Pig.	Gain in 32 Days.	Gain in 46 Days.	Gain Per Day in 46 Days.
Peanuts..................	116½	73½	104½	2.2
Soja Beans..........	124¾	22¾		
Corn	139	76⅓	112⅓	2.4
Chufas..................	121⅓	39⅓	66	1.4

AREAS AND AMOUNT FOOD CONSUMED IN 46 DAYS; AVERAGE PER PIG, POUNDS AND ACRES.

Foods, Per Pig.	Area in Acres.	Gain Per Pig for that Area—Pounds.
Peanuts	1-12	104½
Corn	7.6 bushels	112⅓
Chufas	1-9	66

RESULTS.

1-12 acre peanuts produced 104½ pounds pork in 46 days.
1-9 acre chufas produced 66 pounds pork in 46 days.
7.6 bushels corn produced 112⅓ pounds pork in 46 days.

The estimated quantity of pork produced for one quarter acre of each food:

¼ acre peanuts, 313 pounds pork.
¼ acre chufas, 148 pounds pork.
¼ acre corn, 109 pounds pork.

With the corn-fed pigs the ratio of gain to corn consumed is quite large, but the thrifty condition of the pigs and their size at the beginning of feeding, and the short period of feeding, are doubtless the causes.

The peanut pigs gained practically as much as the corn pigs and harvested their own food.

YIELD OF PEANUTS, CHUFAS AND SOJA BEANS PER ACRE, WHERE GATHERED BY THE PIGS.

Peanuts	30 pounds per bushel.	87 % of good stand.	90 bushels.
Chufas	38 " " "	75 " " "	184 "
Soja Beans	60 " " "	Good stand.	27.2 "

The pigs could not gather those quantities of peanuts and chufas from the soil, but they were compelled to gather the nuts as well as possible without expending too much time and effort satisfying their appetites. The quantity of nuts left in the soil was not estimated.

QUALITY OF PORK PRODUCED BY THESE FOODS.

It is a well known fact that beans and peas make a softer flesh and fat than corn. Corn pork is the standard in this country, and the flesh and fat produced by corn in this experiment was dry and firm. Soja beans and chufas made fat of about the same firmness, but not quite equal to corn Peanuts made a soft and oily fat. As to the flavor when cooked, no difference between the meats could be detected. The usual practice, when pigs are fattened on other foods than corn and grain, is to feed corn to them for a few weeks to harden the flesh and fat before marketing.

R. L. BENNETT.

ORCHARD CULTIVATION.

BY J. T. STINSON.

The cultivation and care of the orchards in this State is an important question, and one that is demanding the attention of many commercial fruit growers.

Improved methods of culture are practiced by some, but in many instances the orchard is the most neglected spot on the farm; and even with commercial growers this is sometimes the case.

During the last few years some of the causes of loss in the apple orchards of the northwest section of the State have been carefully studied, and the conclusion was reached early in the investigation that the loss in most orchards is caused by neglect.

A few orchards have been visited where cultivation is kept up throughout the season. In some, pruning the trees carefully and keeping them free from borers had been practiced, but very few were sprayed for fungus diseases and injurious insects.

The opinion is quite general that an orchard can take care of itself; that the trees do not exhaust the soil, and that they do not need moisture in the soil to mature the fruit the same as other crops.

The results of these investigations in the orchards convince one that better methods will pay, and that the life of an orchard depends upon better methods of cultivation. With the methods usually practiced, the tendency is toward short-lived orchards.

The drouths that occur late in the summer are very trying on bearing fruit trees, which need all the available moisture at this time; and if the crop is heavy, the supply, under the cultivation usually given, is not sufficient to meet the demands of the trees. The result is, that the crop of apples is not properly ripened and the tree is often damaged beyond recovery.

Apples from cultivated orchards ripen later than from the uncultivated, and the fruit hangs on the trees better and is in good market condition after the fruit from the uncultivated orchards is necessarily disposed of, often at a sacrifice.

The drouth of last year, as well as those of preceding years, has taught the fruit growers of this section many valuable lessons regarding the care of orchards, hence will follow better methods of culture to prevent loss from a like cause in future years.

The dying of trees in the apple orchards, after they come into bearing, is becoming a serious question among orchardists. The causes may be many, but the drouths that we usully have just before the ripening of the fruit is a cause of much of the loss. The starving of the trees is also another cause of much loss, as the orchard is often planted on land from which the supply of plant food has been largely exhausted by previous crops.

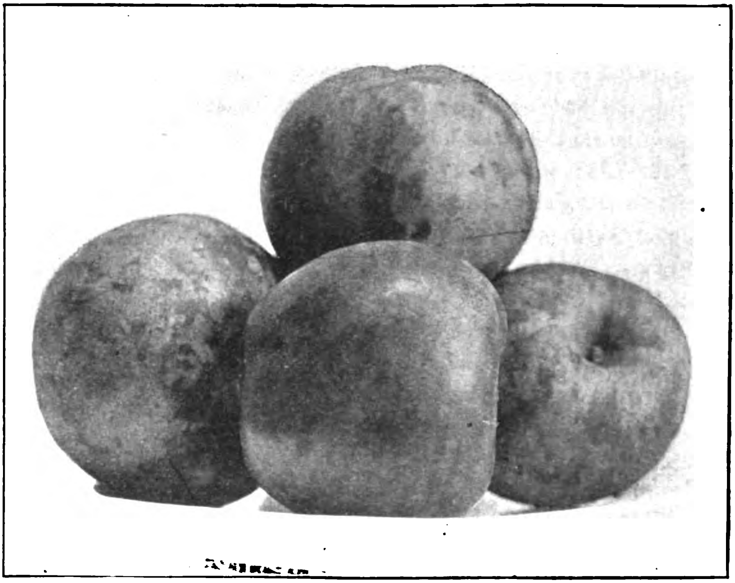


Fig. 1. Apple Skin-Blotch. (*Leptothyrum pomi.*)

Location.—One of the first requisites for a good orchard is a suitable location. High lands are preferable, since they give the air drainage which is so necessary for successful fruit culture; the soil being much more thoroughly drained and the fruit coloring up better on the elevated lands.

Soils devoted to orchard purposes should have natural drainage or be drained artificially, as a cold wet soil will not give the best results in fruit culture. Land inclined to be wet or having wet spots in it, should be thoroughly drained before trees are set.

The disease "Apple Skin Blotch," is rarely met with in orchards on the high lands of this section of the State, but occurs on the fruit grown on the less elevated locations to an extent that necessarily lowers its selling price. This disease is mentioned in Bulletin No. 39 from this Station, and cut No. 1 shows the disease on the fruit.

The best soil is none too good for an orchard, as the trees are expected to occupy the land for a number of years, and it requires a good soil to furnish the constant supply of plant food consumed by the trees. The trees, after coming into bearing, will consume, in producing fruit, leaves and wood growth, more plant food than would be required by ordinary farm crops for the same period. In Bulletin No. 103 from the Cornell Experiment Station, Professor Roberts gives a table showing the amount of plant food used by an orchard for a period of twenty years after coming into bearing, to be much more than would be required for a continuous crop of wheat during the same period.

Steep hillsides should be avoided for orchard purposes, as on such locations it is difficult to keep the land in proper shape.

The value of the orchard depends, to a large extent, upon the preparation of the soil before planting the trees. Most soils in the apple section will be greatly benefited by subsoiling, and if it is practical the whole field should be subsoiled. This will give a loose bed of soil for the roots of the trees, and will allow them to strike deeper than they otherwise would. Deep rooted trees will withstand the drouth better and live longer than those with shallow roots.

A preparatory crop which will assist in putting the soil in good tilth and add plant food is a valuable aid in the preparation of the soil for the reception of the young trees. A crop of peas, turned under, can be used to good advantage for this purpose, also red clover, grown for two or three years.

Either fall or early spring is the best time for setting trees. As a rule, however, most of the orchards of this section are set in the early spring; nevertheless there is much to be said in favor of fall planting. The principal reason for favoring the fall planting is that the trees become well established and are ready to grow in early spring.

Other advantages of fall planting are that the wounds made in transplanting heal over during the winter, and the soil is usually in better condition for setting trees than in spring, which is usually a much busier season on the farm than the fall, and the setting of the trees is often put off until too late for best results. The earlier a tree can begin growth in the spring, the more likely will it be to grow well from the start.

In choosing the distance between trees, much depends upon the character of the soil and the kind of cultivation the orchard is to receive.

Orchards are often planted with wide rows running north and south, with the trees close together in the rows. This gives a better opportunity to grow crops between the rows, and also allows necessary room for gathering the fruit. Orchard trees should not be set so close as to prevent driving between the rows when gathering the crop or spraying the trees.

The following distances will be found safe for setting apple trees: Rows, 40 feet apart and trees from 20 to 24 feet apart in the rows, or trees may be set from 30 to 35 feet each way.

Peaches may be set 20 feet each way, or they may also be planted in rows with the wide space running north and south.

None but good trees should be planted—poor trees are dear at any price, and the cost of good trees is but a small part of the cost of the orchard.

It is always desirable to buy trees from local nurseries as it is usually not only a saving in money, but in most cases, much better stock is secured, as well as varieties that are better adapted to the locality.

Good nursery stock is grown in this State and by buying from home nurseries the stock is usually delivered in better condition than is possible from a distant nursery, besides the saving in freight.

For orchard planting, one year old apple trees will generally give the best results; two year olds may be planted to good advantage, but older trees should not be set out. Peach and plum trees are planted one year old from the bud.

There are several reasons for preferring the one year old apple trees for planting; they cost less, are more easily set, and the head can be formed at the desired height more readily than with older trees. The one year old trees are not set back on account of transplanting as the two year olds are, and they will, other things being equal, have a better root system.

All roots should be trimmed smoothly before setting the tree. The amount to trim from the tree at setting time, or rather the amount to retain, brings up a question that has been much discussed of late. Some advocate cutting away most of the root and leaving only a stub with short branches to represent the root system, with a shortening of the tops of the trees to correspond, while others advise cutting no more of the root than is absolutely necessary. Judging from the results of investigations here at the Experiment Station, close root pruning renders the tree less likely to grow since there was a smaller per cent of the root pruned trees that lived than those planted in the ordinary way, yet many of them made good growth, and in some cases the roots reached a greater depth than the others. In either case, however, it is advisable to shorten the tops to correspond to the amount of roots lost in taking from the nursery. About one-half of the root system of the two year old and one-third that of the one year old tree is lost by this process.

The holes which are to receive the trees should be large enough to accommodate the roots in their natural position, and in hard, unsuitable soil, the holes should be quite large, so that a greater quantity of surface soil may be put in to furnish accessible plant food until the trees have become established.

An important item in tree planting is the packing of the soil firmly about the roots, which is often neglected in the hurry of orchard setting. The loose earth should be worked in between the roots until the entire space is filled and firmly packed.

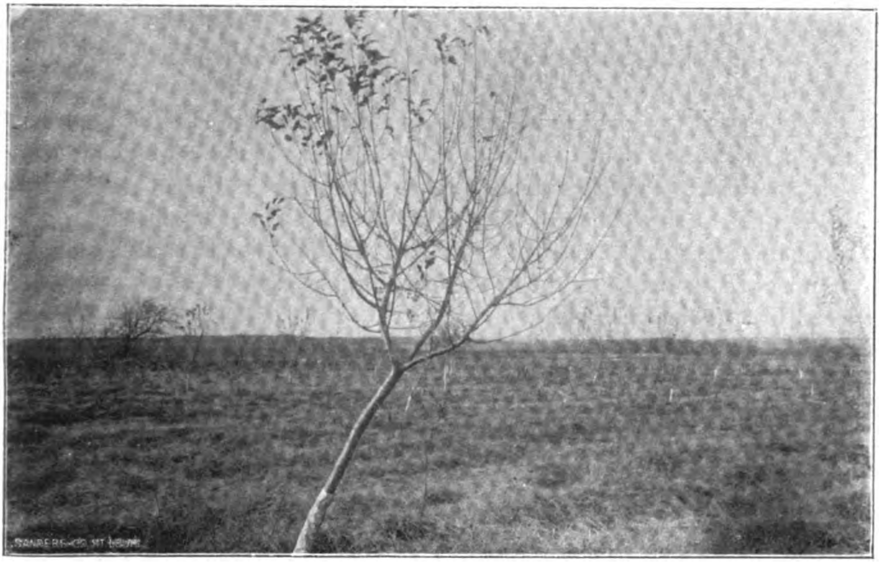


Fig. 2.

The trees in this orchard were not properly headed when set, and the result is that most of them are top heavy, and are leaning badly.

Trees are usually trimmed after they are set, as the work can be done better. Many of the failures to secure a good growth from newly set trees are due to the tops all being left on the tree when set.

There is much difference of opinion among fruit growers as to the best methods of pruning fruit trees, and no definite rules can be recommended, as varied conditions and locations require different methods.

If pruning is begun when the trees are first set out and carefully done each year for the first few years, there will be little need of severe pruning later.

The tops of one year old apple trees are usually cut back to within 20 to 24 inches of the ground when they are set, so that the head may be started low, and two year olds may be headed equally low by carefully cutting them back.

It is important when the annual prunings are given that care be taken not to allow limbs to grow opposite each other forming a crotch. This is an evil that can be easily remedied when the trees are young, but it is a great detriment when they come into bearing as they often split when loaded with fruit.

All superfluous wood, such as cross limbs and water sprouts should be cut away each year.

Low heading also has its advantages with peach trees, and the trees may be cut back to within 14 to 20 inches of the ground after they are set.

Shortening in the top annually has its advantages and is generally practiced in the peach orchards. Some of the advantages are that a greater number of trees can be planted to the acre, the fruit is more easily gathered and there is less danger of the trees overbearing, as a part of the new bearing wood is cut away each year.

Cultivation.—The mistake is often made of delaying plowing and subsequent cultivation of the orchard in the spring until the season for planting the summer crops, and on account of the delay much of the moisture stored up there from the winter rains is lost. The cultivation of the orchard should begin as soon as the soil is in condition for working, and soils that will not admit of early cultivation should not be chosen for orchards.

An important subject that the orchardists of apple and peach growing sections as well as all fruit growers should consider is the conservation of moisture in the soils of the orchards.

The soil is similar to a sponge in holding water by capillary attraction. During dry weather the moisture is constantly escaping from the soil by evaporation, and the water from below takes the place of that which escapes. This occurs during the growing season, and during the drouth periods evaporation continues until the supply from below is exhausted when the trees and growing crops are injured.

The placing on the surface of some obstruction to the capillary movement of the water checks the evaporation.

This obstruction may be a mulch of some kind. A board placed on the ground shows the result. This mulch may be of straw or any coarse material, or a mulch of loose soil will answer the same purpose. Since the upward flow of the water depends upon the compactness of the soil, the loose soil mulch breaks up the channels through which it escapes and places a barrier which holds the moisture in the soil.

A heavy rain compacts the soil and evaporation will be continued until the soil is again stirred and the channels for the escape of the moisture are broken; therefore to hold moisture in the soil, it is essential to cultivate after heavy rains.

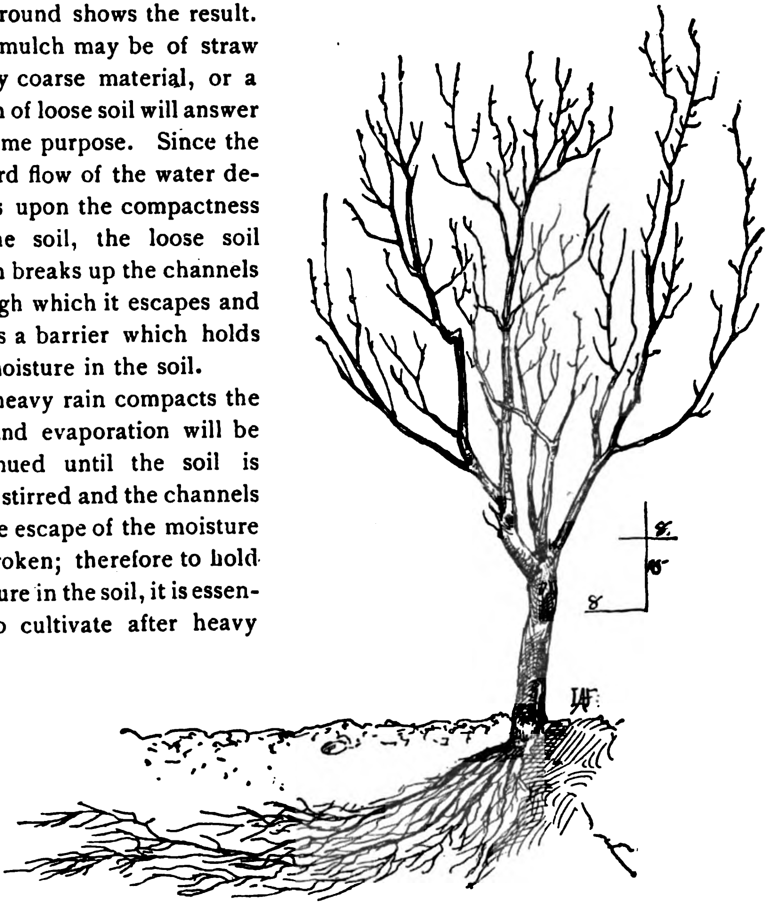


Fig. 3. Roots of an Apple Tree in Good, Tilled Soil.

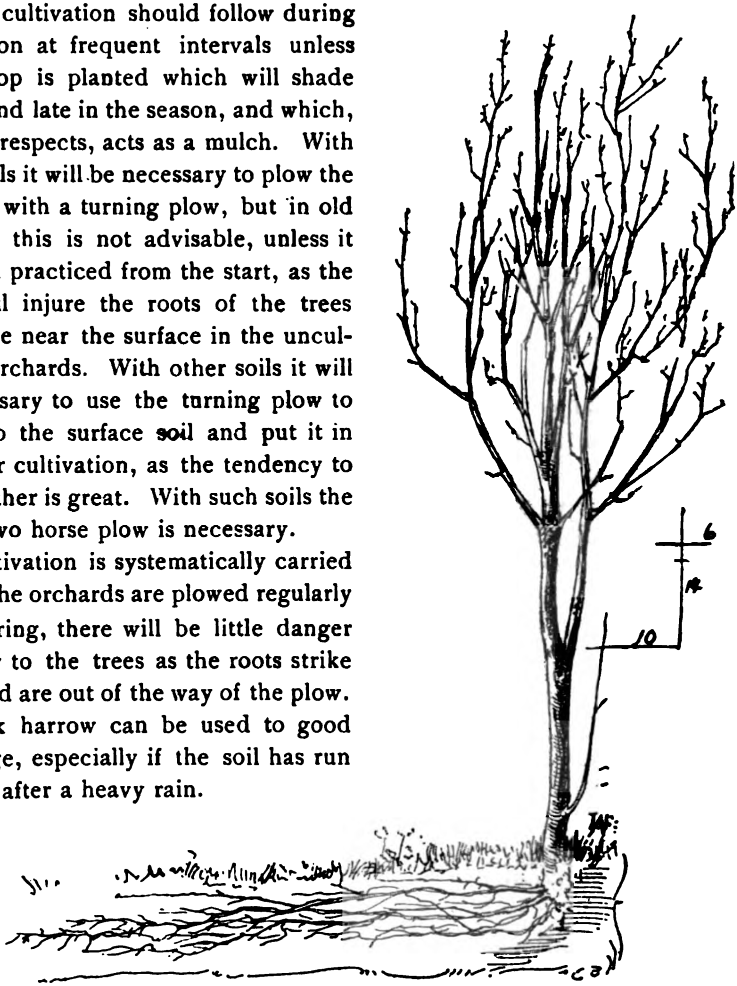
*"This is a Fall Orange apple tree, set in 1889, in rich, well tilled soil. Here the roots are in good pasture and remain at home; yet their spread is twice that of the top which has a diameter of 8 feet, and we were able to follow the roots 8 feet upon the side in which we dug. These object lessons enforce the importance of tilling all the land between the trees."

---

*Bulletin No. 102, Cornell University Experiment Station.

The soil should be worked as early in the season as practicable, as the early plowing prevents evaporation and saves much of the water of the winter rains; it also puts the soil in condition to hold the spring rains. Shallow cultivation should follow during the season at frequent intervals unless some crop is planted which will shade the ground late in the season, and which, in some respects, acts as a mulch. With some soils it will be necessary to plow the orchard with a turning plow, but in old orchards this is not advisable, unless it has been practiced from the start, as the plow will injure the roots of the trees which are near the surface in the uncultivated orchards. With other soils it will be necessary to use the turning plow to break up the surface soil and put it in shape for cultivation, as the tendency to run together is great. With such soils the one or two horse plow is necessary.

If cultivation is systematically carried on and the orchards are plowed regularly every spring, there will be little danger of injury to the trees as the roots strike deep, and are out of the way of the plow. The disk harrow can be used to good advantage, especially if the soil has run together after a heavy rain.



§*Fig. 4.* ROOTS OF AN APPLE TREE IN SOD.

*"This tree is the same age as the other, but has always stood in sod. The roots ran 10 feet in one direction and the total spread of the top was

---

*Bulletin No. 1[illegible]9, Cornell University Experiment Station.

§The cuts for figures 3 and 4 were kindly loaned to the Station by Cornell University Experiment Station.

6 feet; but the roots lie just under the surface. This land could not be plowed without great injury to the tree. Let us consider the relation of this tree to the moisture: the roots are in the driest part of the soil; the grass is pumping out the water and locking it up in its own tissues and sending it into the atmosphere with great rapidity; the soil is baked and pulls out the water by capillary attraction and discharges it into the air; there is no tillage to stop this waste by spreading a mulch of loose and dry soil over the earth. If one were to sink a well under this tree and were to erect a windmill and pump, he could not so completely deprive the tree of moisture. And the less moisture, the less food."

The object is to cultivate so that all the soil is in good condition between the trees as well as under them. By using either the ordinary harrows or the disk, all the soil may be reached without injury to the trees.

The harrow is a good instrument to use as a conserver of moisture, as it stirs the entire surface thus forming the soil mulch which prevents evaporation, and the expense in time and labor is much less than with some other tools.

In some orchards the use of the harrow is not practicable, and instead, a spring tooth cultivator, having several shovels, may be used to advantage. Several small shovels on the cultivator are preferable to a few larger ones as more of the surface is stirred; cultivation is shallower and the soil is not left in ridges. This leveling of the soil is very important, since, if left in ridges, evaporation is more rapid as more of the surface is exposed.

Some of the lands selected for orchards are very rough, rendering cultivation difficult, and under these conditions, the methods advised here are not practical. The conditions are so unlike in the different locations that it is not possible to advise any one method of procedure, but what has been outlined regarding tillage, if practiced, will, as a general thing, give good results with most orchards.

The crops to grow in an orchard depend much upon the nature of the soil and the age of the trees. Corn may be safely grown in young orchards, providing the soil is rich enough to allow it without detriment to the trees. After a few years crops should be grown that will not consum the moisture and plant food which the trees need.

The main objects of cultivation are to increase the fertility of the soil and hold the moisture for the use of the trees during the drouth periods, as well as to prevent the growth of weeds and grass, thus storing up an abundant water supply which renders the plant food contained in the soil more available. Effects of tillage as stated by Professor Bailey are:

> *"It sets free plant food;
> Promotes nitrification;
> Supplies air to the soil and roots;
> Makes all the soil available, by fining it;
> Breaks up the hard-pan;
> Makes a reservoir for water;
> Warms and dries the soil;
> Saves the rain, by taking it into the soil;
> Prevents evaporation, or conserves moisture;
> Sends the roots of the trees downwards, and makes the moisture and the fertility of the subsoil available."

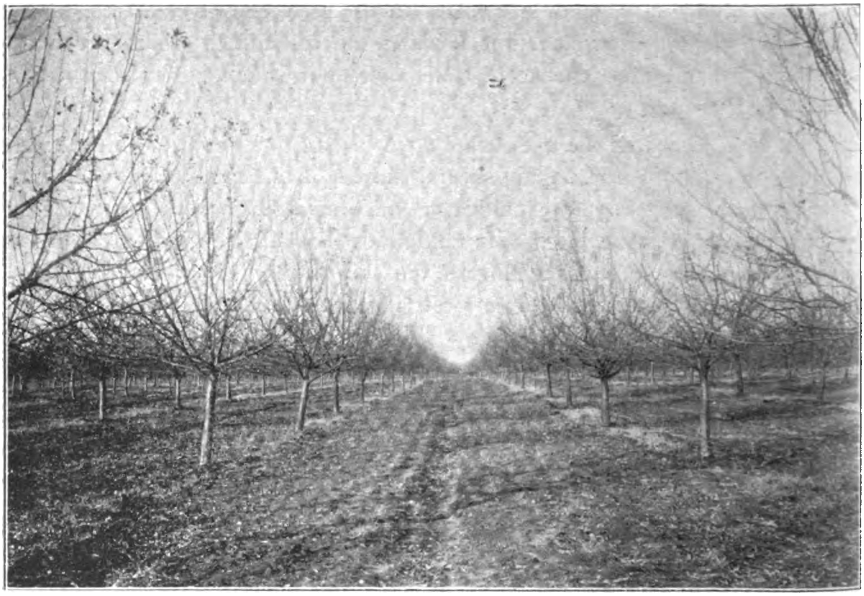


Fig. 5. CULTIVATED ORCHARD.

This orchard has been cultivated regularly since the trees were set. The trees have made good growth but they have been pruned too high for this section. Cowpeas have been usually grown in the summer and sometimes a winter covering of rye has been given.

---

*Bulletin No. 102, Cornell University Experiment Station.

Where red clover does well, it gives good results in bearing orchards, but should not be allowed to grow for more than two years without alternating with some cultivated or clean culture crop. Clover will restore to the soil in two years much of the plant food used by previous crops. It is best to cut it two or three times during the season, allowing it to remain on the ground to form a mulch which helps to prevent the escape of the moisture from the soil by evaporation.

The cowpea gives better results in maintaining the fertility of the soil in orchards of this section than does any other plant, as it will thrive on poor soil when other leguminous plants will not. Wherever a crop of cowpeas is grown the land is enriched, as the growth is rapid, the roots run deep into the soil and the surface is shaded during the summer months. The cowpea is a nitrogen gatherer; it collects nitrogen from the air and stores it up in the roots and vines for the use of other crops. This element of plant food is obtained cheaper by the use of the cowpea or clovers than by any other agency.

The fertilizing value of the roots and stubble after the hay is taken off is considerable, but to get the full benefit, the vines must be plowed under, as they contain a large amount of plant food and are valuable in adding vegetable matter to the soil.

It has been proven by experiments at the Experiment Station of this State, as well as others, that the most economical method of using the cowpea, is to cut and cure the hay, feed to stock and return the manure to the soil, as the feeding of the vines and peas does not diminish their fertilizing value, while producing the additional profit of feed for animals.

Where a winter cover crop is to follow the peas, they may be advantageously plowed under in late fall, but if the land is to be left without such a crop, it is better to leave them on the ground until spring. Although they lose much of their fertilizing value by this method, much is gained by having a cover on the soil through the winter, as such cover is beneficial to the soil, besides preventing its washing and leaching.

The Whippoorwill and black varieties are grown in the Station orchards here exclusively. Where cowpeas are to be plowed under in the fall the Whippoorwill is preferable, as it is a bunch variety; but where the vines are to remain on the ground over winter, the black variety is better, as it makes more vine.

If vines are desired, planting should be done early; but it must be remembered, cowpeas are a warm weather plant and should not be planted here before May. Usually about June the first is sufficiently early for planting, but if the peas are wanted, later plantings give a heavier yield and less vine.

For orchard culture, the best results are obtained from the pea by planting in drills about 2 feet apart, as the soil can be cultivated until the plants are of sufficient size to shade the surface.

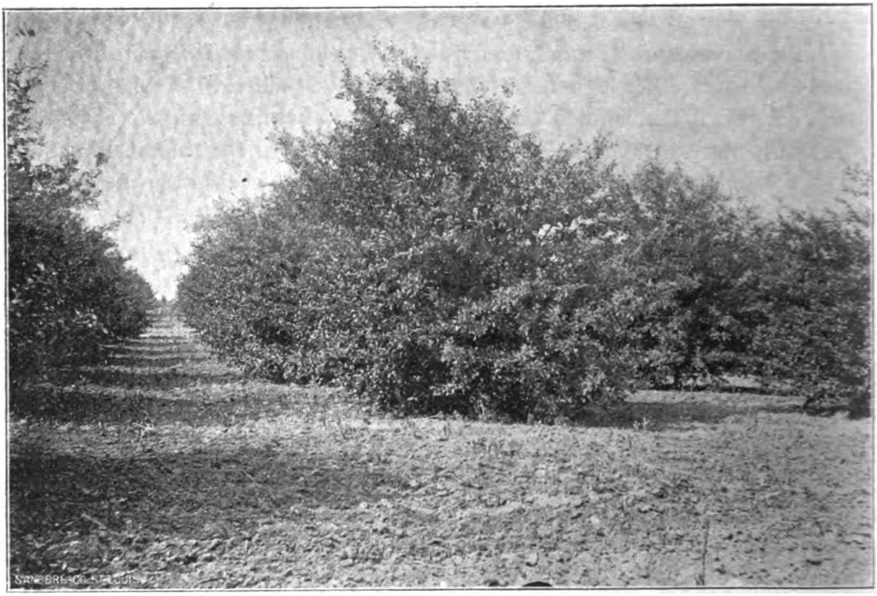


Fig. 6. CULTIVATED ORCHARD.

The trees in this orchard are headed too low, and the cut is shown here to compare with Fig. 5, which is headed too high.

When corn is grown in the orchard, cowpeas may be either drilled just after the last cultivation is given, or sown broadcast just before. Grown in this manner, they usually make a fair growth and help to restore to the soil the plant food taken from it by the crop of corn.

Grass should not be allowed to grow in an orchard; neither should wheat or oats be grown, as they assist in drawing the moisture from the soil and leave the trees without the necessary supply when it is most needed. The growing of grain crops in an orchard results in great damage to it, even if grown only one year.

The soil for fruit trees should contain plant food as well as water, and the two necessarily must be present in sufficient quantities for best results. The lack of plant food in the soil is the cause of much loss in orchard culture. Often the land is badly worn when the trees are set and such land should not be selected for an orchard, but if it is necessary to do so, the soil should be built up previous to setting the trees. The time and expense of getting it in good condition will be wisely expended as the value of the orchard depends upon the supply of plant food.

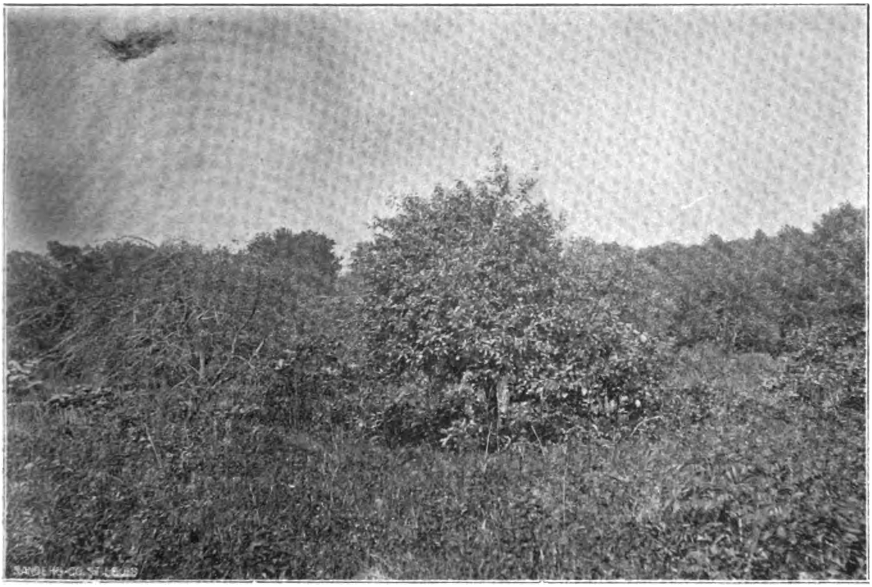


Fig. 7. UNCULTIVATED ORCHARD.

This orchard is composed of good varieties, is on good soil and with good treatment it would produce paying crops of apples. With the lack of care, very light crops of poor fruit are produced.

Barnyard manure is valuable in building up soils, as the supply of humus is greatly increased by it and much plant food added, which is mostly nitrogen, an element badly needed by the worn soil. Most soils that have been cropped are deficient in vegetable matter. Decaying vegetable matter in the soil is commonly called humus. This assists in holding the moisture in the soil, and also prevents it from running together. With clay soils, the addition of vegetable matter prevents them from running together and becoming hard, while the sandy soils are rendered more compact; increasing the amount of humus in the soil increases the fertilizing ingredients and assists in keeping up the supply of plant food. Humus may be added to the soil by the application of barnyard manure, or by the turning under of growing crops or other materials, such as a crop of weeds.

The supply of potash for orchard trees is usually deficient. Where wood ashes can be obtained, they are valuable for supplying this important element of plant food. When applying them it is best to put on a thin coating, spreading them over the entire surface.

Agricultural Experiment Station

FAYETTEVILLE, ARKANSAS

TWELFTH ANNUAL REPORT

1899

Agricultural Experiment Station

FAYETTEVILLE, ARKANSAS

TWELFTH ANNUAL REPORT

1899

ARKANSAS EXPERIMENT STATION,

FAYETTEVILLE, ARK., December 19, 1899.

To His Excellency, DAN W. JONES,

Governor of Arkansas:

SIR—

I have the honor to transmit to you herewith the Twelfth Annual Report of the Arkansas Agricultural Experiment Station.

Most respectfully,

R. L. BENNETT,

Director.

CONTENTS.

Page.

LETTER OF TRANSMITTAL 2

BOARD OF TRUSTEES 4

STATION STAFF 4

FINANCIAL REPORT 5

REPORT OF DIRECTOR 6

EXPERIMENT WITH TOMATOES, CABBAGE AND ONIONS 3

INVESTIGATIONS AS TO THE RELATIVE VIRULENCE FOR THE DOMESTIC ANIMALS OF HUMAN AND BOVINE TUBERCLE 23

EXPERIMENTS IN FEEDING STEERS AND ROTATION AND CULTURAL EXPERIMENTS 97

TESTS OF THE PRODUCTIVENESS OF VARIETIES OF CORN GROWN IN DIFFERENT LATITUDES 111

SECOND REPORT ON ARKANSAS SEEDLING APPLES 123

Agricultural Experiment Station.

BOARD OF TRUSTEES.

His Excellency, DAN W. JONES, *President*.

HON. T. M. SEAWEL.
HON. J. C. MITCHELL.
HON. C. C. HAMBY.
HON. J. B. McDONOUGH.
HON. V. Y. COOK.
HON. T. A. FUTRALL.

HON. H. F. REAGAN, *Secretary*.

BOARD OF CONTROL.

HON. T. A. FUTRALL.
HON. T. M. SEAWEL.
HON. V. Y. COOK.
DR. J. L. BUCHANAN.
R. L. BENNETT.

STATION STAFF.

R. L. BENNETT	DIRECTOR.
W. G. VINCENHELLER	Vice Director and Pomologist.
R. R. DINWIDDIE	Pathologist and Bacteriologist.
C. L. NEWMAN	Agriculturist.
ERNEST WALKER	Horticulturist and Entomologist.
GEO. B. IRBY	Assistant in Feeding Experiments.
J. F. MOORE	Assistant Chemist.

Correspondents should notify the Director of any change of Post Office Address, error in Address, or failure or delay in receiving Bulletins.

R. L. BENNETT, Director,
Fayetteville, Ark.

FINANCIAL REPORT

Agricultural Experiment Station.

In Account with the United States Appropriation.

1899. DEBTOR.

To receipts from the Treasurer of the United States as per Appropriation for the year ending June 30, 1899	$15,000 00
	$15,000 00

CREDIT.

By Salaries	$ 9,524 82
Labor	1,672 43
Publications	584 97
Postage and Stationery	133 60
Freight and Express	210 78
Heat, Light and Water	92 01
Chemical Supplies	406 16
Seeds, Plants and Sundry Supplies	485 13
Fertilizers	
Feeding Stuffs	188 13
Library	271 06
Tools, Implements and Machinery	143 75
Furniture and Fixtures	75 63
Scientific Apparatus	199 49
Live Stock	242 90
Traveling Expenses	564 65
Contingent Expenses	87 50
Building and Repairs	116 99
	$15,000 00

The foregoing Statement is copied from the Experiment Station books, which have been examined and approved by the Auditing Committee of the Board of Trustees.

R. L. Bennett,
Director.

REPORT OF DIRECTOR.

The completed and published experiments during the year were issued in five bulletins which appear in full in succeeding pages of this report.

Bulletin No. 56—Experiment with Tomatoes, Cabbage and Onions.

Bulletin No. 57—Investigations as to the Relative Virulence for the Domestic Animals of Human and Bovine Tubercle.

Bulletin No. 58—Experiments in Feeding Steers—Rotation and Cultural Experiments.

Bulletin No. 59—Tests of the Productiveness of Varieties of Corn Grown in Different Latitudes.

Bulletin No. 60—Second Report on Arkansas Seedling Apples.

The resignation of two members of the station staff occurred during this calendar year. The Chemist, Mr. G. L. Teller, resigned in March and the Horticulturist, Mr. J. T. Stinson, in December. Their resignations were made to accept more lucrative positions elsewhere.

The scope of the station's work was enlarged in June by the appointment of a Pomologist and Institute worker. Very little Institute work has been done heretofore, but the intention now is to make that feature quite prominent, with the expectation that farmers of the State will be aroused to greater interest in scientific agriculture and to an increased use of the station's work.

Henceforth the experimental work of the Horticulturist will be mainly with small fruits and vegetables, for the reason that the trucking interest of the State for early Northern markets is rapidly increasing, and the station is endeavoring to aid the increase and success of the business to the fullest extent.

Experiments made in beef and pork production, to aid those lines of the live stock business, are encouragingly received by interested farmers.

Hog cholera is supposed to be an obstacle in the way of producing pork as a money crop in the State, and while that is true to a limited extent there is probably less loss from it than from diseases caused by neglect and poor sanitary surroundings. The Bacteriologist, Dr. R. R. Dinwiddie, has recently begun work on hog cholera and we hope to secure some useful results. Preparatory to beginning this work Dr. Dinwiddie went to Bussey Institute during his vacation last summer and worked with Dr. T. J. Smith.

R. L. BENNETT,
Director.

INDEX.

See table contents, page 3.

TOMATOES FOR EARLY MARKET.*

East of the Mississippi River, tomato growing for early market is an extensive and profitable industry in many localities. Many tons are shipped North from the States of Florida, Georgia, Mississippi, and the Carolinas, and later from Virginia, Maryland, New Jersey, and Delaware. The first shipments are made in February from Florida, followed closely by crops from the coast region of the lower Southern States, and later by more inland and Northern sections. Prices are usually good until early in July, or until the Northern crop is ready for market, when they decline rapidly and cease to be remunerative for the Southern grower. The Southern States west of the Mississippi River, except around New Orleans and between Galveston and Houston, and a few points in other States, have given but little attention to this crop for the early market, while experiments conducted in the southern portion of this State conclusively indicate that with the proper equipment and experience, this crop could be made to return large profits if fruit of good size and quality are marketed sufficiently early.

To successfully grow tomatoes of the above description, special equipment, knowledge, and experience are essential, as well as some capital.

The experiments reported here were conducted for the purpose of determining whether or not a large yield of tomatoes of good quality and size could be ripened extra early. On January 1 the seed were sown in flats 20 x 30 or 24 x 36 inches, and 2½ or 3½ inches deep. These flats were filled with soil composed of one part well rotted and fined compost, and one part sandy garden soil, to which had been added a fertilizer composed of 8 per cent Potash, 8 per cent Phosphoric acid, and 4 per cent Ammonia.

Seed of ten varieties were sown one-fourth of an inch deep in rows 3 inches wide. The trays were placed on earth-covered benches in a 15 x 30 foot glass house, in which the temperature was not allowed to go below 50 degrees F., and ranged between 70 and 85 in the daytime. As the season advanced, the temperature was raised gradually until two weeks before the final transplanting, when no artificial heat was used, but the greenhouse left open, that the plants might become accustomed to outside conditions, or be hardened off. After March 1 very little artificial heat was necessary by day, and not always by night. The cost of heating through January, February, and March averaged a little less than 13 cents per day for 450 square feet of greenhouse area. This, however, does not include the cost of the heating apparatus, which was $10.

---

*The experiments reported in this bulletin are the last of those made in the southern part of the State, and were conducted for the purpose of furnishing information and aid in the development of truck growing for Northern markets, in parts of the State adapted to that line of farming.

Ten plants each of ten varieties of tomatoes were subjected to different treatments after the first rough leaf appeared and up to the time they were transferred to their permanent places in the field.

In growing tomatoes, and particularly the extra early ones, the product is greatly influenced by the character and vigor of the young plants, and their character and vigor are controlled by the apparently insignificant details attendant upon their proper early management and surroundings. These many essential details one can become familiar with only through experience and the exercise of applied common sense. The artificial conditions necessary in the early growth of the plants should be made as near the same as the requirements of the plant as possible, and from the germination of the seed on to the ripening of the fruit, a quick, sturdy growth must be maintained regularly if a marked degree of success is expected.

The soil upon which the tests were conducted was a very light sandy loam, and had grown vegetables for two years with moderately heavy applications of stable manure, cotton seed meal and commercial fertilizers. An adjacent plot, which had been manured with a slightly greater quantity of manures and fertilizers, produced a little more than 200 bushels per acre of Irish potatoes the same year.

Rye was sown broadcast over the plots in October of the previous year, and covered the ground to the depth of 6 or 8 inches when plowed under three weeks before the tomato plants were set in the field. Before the rye was plowed under, 750 pounds per acre of cotton seed meal was broadcasted over the rye, and both plowed in to the depth of 10 inches. Before the plants were set the field was harrowed twice, when the rows were marked off without ridging, and the plants set 3 x 4 feet. As soon as the plants were set, a cultivator was dragged through the rows to counteract the effects of trampling. The plots were cultivated every ten or fifteen days, and always after rain as soon as the soil was in condition to be stirred, thus keeping a loose earth-mulch on the surface at all times.

The precipitation as recorded by a gauge situated a few feet from the plots was as follows:

March	8.48 inches.
April	4.38 inches.
May	2.78 inches.
June	2.67 inches.

Deficient rain, high winds, and high temperature in June and July so affected the plants that no fruit of consequence was gathered after the middle of July. This, however, had no vitiating effect upon the object of the experiment, and no record was kept later than June 30.

All plots were pruned of branches occurring below the first blossom cluster, and the plants tied to stout stakes. Each plot was three times sprayed with Bordeaux mixture and the tobacco worms, which were numerous, removed by hand.

PLOT I.

As was the case with each lot of plants, the seed were sown in flats on January 1. When the third, or first rough leaf appeared, the plants were shifted to other flats and set 1 x 1 inch. Before they became crowded they were again shifted to flats and set 3 x 3 inches. Each plant was taken up with its alloted portion of soil. To facilitate this, a knife was passed both ways between the rows of plants, thus cutting the soil into square blocks, with a plant in the center of each block. When the 3 x 3 inch plants begun crowding they were again cut out and shifted to quart strawberry boxes, where they remained until transplanted in the field on March 30. The plants were then 12 to 15 inches high and beginning to blossom. In transplanting to the field, the plants were not taken from the berry boxes, but set box and all so that the top of the box was 4 inches beneath the surface of the ground. The earth was firmly pressed about the boxes with the foot, and the surface covered with loose and fined soil.

PLOT I.

Name of Variety.	Date of First Ripe Fruit.	Number of Fruit per Plant that Ripened before July 1.	Total Weight.	Average Weight.	Largest Specimens.
	May.	Lbs.	Lbs.	Oz.	Oz.
Aristocrat	4	14.7	6.52	7.1	13
Beauty	5	17.3	4.75	4.4	7
Dwarf Champion	2	16.1	3.42	3.4	4.5
Imperial	7	10.4	4.35	6.7	10
Lemon Blush	4	21.9	5.61	4.1	5
Matchless	7	18.6	5.58	4.8	9
Mikado	8	24.3	12.75	8.4	18
Perfection	5	21.4	8.15	6.1	10
Ponderosa	8	20.0	10.50	8.4	19
Stone	4	23.4	7.45	5.1	9.5
Average	5.4	18.81	6.908	5.85	10.5

PLOT II.

The treatment of this lot of plants was identical with those of Plot I up to the time they were transferred to the strawberry boxes. Instead of the berry boxes, flats 3½ inches deep were used, the plants being set 4 x 4 inches, where they remained until the final transplanting, on March 30, when a block of soil 4 x 4 x 3½ inches was removed with the plants. The plants were set as were those in the berry boxes, 4 inches deeper than they had grown in the flats.

PLOT II.

Name of Variety.	Date of First Ripe Fruit.	Number of Fruit per Plant that Ripened before July 1.	Total Weight.	Average Weight.	Largest Specimens.
	May.	Lbs.	Lbs.	Oz.	Oz.
Aristocrat	7	18.0	7.65	6.8	10.5
Beauty	5	16.0	4.75	4.5	10
Dwarf Champion	8	13.6	2.63	3.1	5
Imperial	9	7.5	2.76	5.9	9
Lemon Blush	13	23.1	6.06	4.2	4.5
Matchless	10	18.9	5.07	4.3	8
Mikado	9	20.7	9.70	7.5	16.5
Perfection	10	18.2	6.93	6.1	11
Ponderosa	14	22.0	11.13	8.1	21
Stone	9	18.1	4.52	4.0	7.5
Average	9.4	17.61	6.12	5.45	10.3

PLOT III.

This lot of plants was treated as Lots I and II up to the shift to 3 x 3 inches into flats, where they remained until the final transplanting, on March 30, when, with a 3-inch square of earth, they were set 4 inches deeper than they stood in the flats. When transferred to the field they were somewhat long-legged, from too close crowding while in the flats.

PLOT III.

Name of Variety.	Date of First Ripe Fruit.	Number of Fruit per Plant that Ripened before July 1.	Total Weight.	Average Weight.	Largest Specimens.
	May.	Lbs.	Lbs.	Oz.	Oz.
Aristocrat	16	14.5	5.80	6.4	8.5
Beauty	8	20.1	5.52	4.4	6
Dwarf Champion	11	10.8	2.29	3.4	5
Imperial	18	11.3	3.60	5.1	8
Lemon Blush	16	18.4	4.71	4.1	6
Matchless	21	20.1	5.02	4.0	7.5
Mikado	18	19.9	8.52	6.9	10.5
Perfection	12	20.6	6.45	5.1	6.5
Ponderosa	19	30.0	11.81	6.3	12
Stone	14	19.1	4.53	3.8	5
Average	15.3	18 48	5.82	4.95	7.5

PLOT IV.

These plants were shifted to 2-inch pots when the first rough leaf appeared, and later to 3-inch pots, from which they were transferred to the field on March 30, and set so that the top of the ball of earth was 4 inches below the surface of the ground.

PLOT IV.

Name of Variety.	Date of First Ripe Fruit.	Number of Fruit per Plant that Ripened before July 1.	Total Weight.	Average Weight.	Largest Specimens.
	May.	Lbs.	Lbs.	Oz.	Oz.
Aristocrat	4	9.2	3.50	6.1	10
Beauty	5	8.4	2.25	4.3	7
Dwarf Champion	6	6.0	1.35	3.6	4
Imperial	7	9.4	2.40	4.1	6
Lemon Blush	11	19.4	3.39	2.8	6
Matchless	14	12.0	3.27	4.7	6
Mikado	13	13.6	4.93	5.8	9.5
Perfection	9	14.0	4.81	5.5	6.5
Ponderosa	8	16.4	6.56	6.4	9
Stone	4	14.6	4.08	2.8	4
Average	8.1	12.30	3.65	4.61	6.8

PLOT V.

These plants were not disturbed until the final transplanting of March 30. They were allowed to remain in flats, and became long-shanked. No soil could be removed with the roots, but the plants were set 4 inches deeper than they stood in the flats.

PLOT V.

Name of Variety.	Date of First Ripe Fruit.	Number of Fruit per Plant that Ripened before July 1.	Total Weight.	Average Weight.	Largest Specimens.
	May.	Lbs.	Lbs.	Oz.	Oz.
Aristocrat	15	16.1	4.33	4.3	7
Beauty	17	22.8	4.42	3.1	4
Dwarf Champion	14	12.4	1.86	2.4	4.5
Imperial	18	14.1	3.60	4.1	5
Lemon Blush	21	23.3	2.91	2.0	3.5
Matchless	22	13.7	2.59	3.1	4.5
Mikado	18	14.8	4.53	4.9	9
Perfection	15	18.1	3.17	2.8	4
Ponderosa	21	15.2	4.03	4.9	7.5
Stone	18	23.4	2.63	1.8	4
Average	17.9	17.39	3.40	3.34	5.3

PLOT VI.

These plants were treated the same as Plot V, except that they were set only as deep as they grew in the trays. To prevent their falling over it was necessary that they be staked when put out.

PLOT VI.

Name of Variety.	Date of First Ripe Fruit.	Number of Fruit per Plant that Ripened before July 1.	Total Weight.	Average Weight.	Largest Specimens.
	May.	Lbs.	Lbs.	Oz.	Oz.
Aristocrat	17	11.4	2.07	2.9	5½
Beauty	16	16.3	2.44	2.4	3
Dwarf Champion	16	9.0	.98	1.7	2½
Imperial	18	8.5	1.55	2.9	3½
Lemon Blush	14	14.3	1.25	1.4	3
Matchless	20	15.7	3.63	3.7	4
Mikado	18	13.9	3.56	4.1	5
Perfection	14	16.8	2.52	2.4	3
Ponderosa	21	10.2	2.80	4.4	6½
Stone	18	14.1	1.80	2.1	3
Average	17.2	13.02	2.26	2.8	3.9

The averages of the different varieties included in each of the six plots indicates that the productiveness, size, and earliness of the fruit are proportionate with the vigor of the young plants, and that the vigor of the plants is controlled by their early treatment. The average yield per acre was 340.49 bushels, and the highest 500.94 bushels. Plots I, II, and III gave yields above and Plots IV, V, and VI, gave yields below the average, the former being given the best attention, and the latter but indifferent, or such as is ordinarily given tomato plants for early fruiting. A comparison of Plots I and VI is interesting. The young plants of Plot I at no time were allowed to become crowded or stunted, and yielded a little over 500 bushels per acre of excellent tomatoes, while Plot VI produced 164 bushels from plants that were crowded and long-shanked, and set only as deep as they grew in the seed flat. A difference of 336.87 bushels per acre, due to treatment differing only up through the final transplanting into the field, while the difference in the total cost of growing the fruit of the two plots was less than $20 per acre.

The following table gives the

AVERAGES OF PLOTS I TO VI.

	Average date of First Ripe Fruit.	Average Number of Fruit per Plant that Ripened before July 1.	Average Weight per Plant.	Average Weight of Tomatoes.	Average Weight of Largest Tomatoes.	Yield per Acre in Bushels—50 lbs. to Bushel.
	May.	Lbs.	Lbs.	Oz.	Oz.	Bushels.
Plot I	5.4	18.81	6.90	5.85	10.5	500.94
Plot II	9.4	17.61	6.12	5.45	10.3	444.31
Plot III	15.3	18.48	5.82	4.95	7.5	422.53
Plot IV	8.1	12.30	3.65	4.61	6.8	264.99
Plot V	17.9	17.39	3.40	3.34	5.3	246.84
Plot VI	17.2	13.02	2.26	2.80	3.9	164.07
Average	12.2	16.26	4.69	4.50	7.38	340.49

THINNING TOMATOES TO INCREASE SIZE OF FRUIT.

This test was conducted with two lots of twenty-five plants each, each lot having five plants each of five varieties. The plants were of very uniform size and vigor, and were treated exactly alike throughout their period of growth in all respects, except the number of fruit was restricted in one lot and was not restricted in the other.

The soil in which the tomatoes were grown was in excellent tilth. For three years previous it had been heavily manured for vegetables of various kinds, and was given a heavy application of commercial fertilizers for this crop. All lateral branches below the first cluster of blossoms were pruned off with a sharp knife. The plants were tied to stakes and the lot that was allowed to produce what fruit it would required no further attention other than the necessary cultivation and occasional tying, as the plants grew. The plants were all sprayed occasionally with Bordeaux mixture, and while the plants were yet wet with the spray, were dusted with Paris green, mixed with four parts of flour or road dust. The other lot was given the same treatment, except that not more than three fruits were allowed to remain upon one cluster, and generally only two. The thinning was done as soon as the young tomatoes were half or three-fourths of an inch in diameter. The dead blossoms were removed as soon as possible to prevent deforming. Frequently the young tomatoes, when not more than one-fourth of an inch in diameter, would show an irregular or improper shape—this was of considerable advantage in enabling the selection of only the best fruit to remain on the vines. The thinning was done with a sharp knife.

Deficient rainfall and excessively high temperature in the latter part of June and through July affected the thinned plots less than those not thinned, since a majority of the fruit on the former had ripened earlier than July 1.

The following table gives the results in detail:

FRUIT THINNED.

Name of Variety.	Average Number of Fruit per Vine.	Total Weight of Fruit per Vine. Lbs.	Average Weight of Single Fruit. Oz.	Weight of Largest Single Fruit. Oz.
Favorite	9.5	8.10	13.60	17.0
Imperial	10.0	8.50	13.60	15.5
Mikado	9.0	11.00	19.50	24 0
Ponderosa	10.0	13.00	20.80	23.0
Stone	10.0	7.25	11.60	15.0
Average	9.7	9.57	15.82	18.9

FRUIT NOT THINNED.

Name of Variety.	Average Number of Fruit per Vine.	Total Weight of Fruit per Vine. Lbs.	Average Weight of Single Fruit. Oz.	Weight of Largest Single Fruit. Oz.
Favorite	23	9.75	6.70	12.5
Imperial	18.5	7.25	6.20	16.0
Mikado	26.5	12.50	7.50	19.0
Ponderosa	29	14.00	7.70	17.3
Stone	26	9.50	6.20	13.0
Average	24.6	10.60	6.86	15.56

EFFECTS OF REMOVING TOMATO FRUIT CLUSTERS UPON THE WEIGHT AND QUALITY OF THE FRUIT.

Forty plants of Mikado were transplanted to rows 3½ x 4 feet, and divided into eight plots, of five plants each, for the purpose of studying the effect of restricting the number of fruit upon the yield and quality. All branches were removed that occurred below the first fruit cluster, and none were allowed to grow after the requisite number of clusters had become well established. Plot I was restricted to one fruit cluster, Plot II to two fruit clusters, and so on through Plot VIII, which bore eight clusters. The leaves of the plants of Plot I became very large, fleshy, and were, in majority of cases, covered with adventitious buds, which developed into branches, some of which bore fruit of inferior quality. These adventitious buds did not develop until the fruit of the one-cluster plot were well advanced towards ripeness. The fruit of Plot I was practically worthless—but few specimens either ripening or coloring uniformly. Several cracked open, and all had an acrid or bitter taste, and were hard and knotty in places. The fruit of Plot II was considerably superior to that of Plot I, but partook to a more or less extent of its abnormal characteristics. An occasional adventitious branch appeared upon the leaves, and but few of the tomatoes were of good quality. The remainder of the plots bore excellent fruit, with the exception of Plots VII and VIII. These were smaller and more irregular in shape than Plots III and VI inclusive. Detail results will be found in the following table:

	Number of Clusters left on Vine.	Total Number of Fruit per Vine.	Total Weight of Fruit per Vine in Ounces.	Average Weight of Fruit per Vine in Ounces.	Weight of Largest Fruit in Ounces.
			Oz.	Oz.	Oz.
Plot I	1	4.00	15.00	3.75	4.5
Plot II	2	10.50	51.45	4.90	11.0
Plot III	3	14.00	98.00	7.00	14.0
Plot IV	4	19.20	144.00	7.50	18.0
Plot V	5	20.25	106.31	5.25	14.0
Plot VI	6	24.00	144.00	6.00	14.0
Plot VII	7	26.50	119.25	4.50	10.0
Plot VIII	8	25.00	75.00	3.00	11.5
Average		17.93	94.12	5.23	12.12

FIVE YEARS WITH ONIONS.

In the spring of 1893 a series of tests were begun that a comparison might be made between the yields of onions grown directly from the seed on the one hand, and starting with artificial heat and transplanting on the other. Eight varieties were grown five years, ten, four years, and twelve, three years. Each year duplicate plots were grown, one from seed planted in the open in February or March, and the other started either in hotbeds or greenhouses and transplanted. The two plots of the same varieties were, in each case, adjacent. The transplanted onions ripened from two to nineteen days earlier than the others, and averaged nine and one-fourth days earlier. The average of culls were 5½ and 14 per cent in favor of transplanting. The keeping qualities of the two lots in the years 1895 and 1896 were slightly in favor of the transplanted onions. The record of the five years' test appears below:

	1893.		1894.		1895.		1896.		1897.				
	Seed Planted March 13, Transplanted when ¼ inch in Diameter.	Seed Planted March 13, not Transplanted.	Seed Planted March 3 and 4, Transplanted when ¼ inch in Diameter.	Seed Planted March 3 and 4, not Transplanted.	Seed Planted January 3 and 4, Transplanted March 1 and 2.	Seed Planted February 25, not Transplanted.	Seed Planted January 1, Transplanted March 14.	Seed Planted February 28, not Transplanted.	Seed Planted January 1 and 2, Transplanted February 26 and 27.	Seed Planted February 25 and 26, not Transplanted.	Average Yield per Acre of Transplanted Plots.	Average Yield per Acre of Plots not Transplanted.	Increase of Transplanted Plots.
	Bushels per Acre.		Bushels per Acre.		Bushels per Acre.		Bushels per Acre.		Bushels per Acre.		Bushels per Acre.		
Bermuda Red	131	129	141	148	118	97	125	108	134	126	129.8	121.6	8.2
Danver's Yellow	114	101	139	142	102	119	154	130	118	109	125.4	120.2	5.2
El Paso	....	....	....	....	149	141	165	52	147	121	153.6	104.6	49.0
Gigantic Gibralta	....	....	....	....	159	168	182	127	149	127	163.3	140.6	22.6
Giant White Tripoli	104	90	139	113	143	138	179	164	133	131	139.6	127.2	12.4
Mammoth Silver King	81	86	121	104	140	118	157	121	141	120	128.0	109.8	18.2
Red Globe	172	157	135	119	114	95	180	75	138	113	147.8	111.8	36.0
Red Rocco	126	118	141	113	189	179	168	139	147	101	154.2	130.0	24.2
Westerfield Red	....	....	148	138	164	127	162	125	110	121	146.0	127.7	18.2
White Globe	96	94	146	131	151	140	175	141	137	108	141.0	122.8	18.2
Prizetaker	....	....	158	118	164	137	190	131	158	121	167.5	126.7	40.7
Yellow Globe	132	113	104	109	134	121	147	123	141	109	131.6	115.4	16.2
Average, 5 years	....	....	....	....	....	....	....	....	....	....	143.991	121.552	22.439

EFFECTS OF SUBSOILING LIGHT SANDY SOIL.

In the fall of 1896 an area of sandy soil was plowed with turnplow and subsoiled to the depth of 18 or 20 inches. An adjacent equal area was plowed in like manner, but not subsoiled. The following spring these areas were divided into six plots in such manner as to have half of each plot on the subsoiled area and half on the area not subsoiled. One of each of the six plots was planted in cabbage, cauliflower, tomato, potato, eggplant, and corn. The yield of the crops was as follows:

	Subsoiled.	Not Subsoiled.
Cabbage—25 Jersey Wakefield to plot..	105 lbs.	84⅛ lbs.
Cauliflower—10 Early Snowball to plot.	19½ lbs.	15 lbs.
Tomato—10 Mikado to plot	71 lbs.	58 lbs.
Irish Potato—Early Ohio, 1-35 acre....	214 bu. per acre	187 bu. per acre
Eggplant—10 White Pearl to plot	114½ lbs.	74 lbs.
Corn—Improved Leaming, 1-35 acre....	19.56 bu. per acre	13.41 bu. per acre

These tests indicate a greater advantage from subsoiling light soil than would ordinarily occur, and the marked effects are probably due to two conditions (either of which would have a tendency to intensify the effect of subsoiling), and conditions that frequently prevail in the sandy sections of the State. The most potent of these conditions undoubtedly was the severe drouth of 1897, and the other was the extreme shallow plowing to which the soil had previously been subjected. It is very probable that the area upon which the experiment was conducted had never before been plowed 4 inches deep. This belief was confirmed by the hardpan of 2 inches in thickness that was 4 and 5 inches beneath the surface of the ground. While the hardpan was easily penetrated and broken by the plow, it interfered with both the circulation of air and water, and the deeper penetration of roots. It is quite probable that large areas of the lighter soils of the State would be greatly benefited by subsoiling once in four or five years, if the subsoil were left in original position and not brought to the surface.

LEVEL VS. RIDGE CULTURE WITH CABBAGE.

As is the case with many growers of potatoes, many truckers plant their cabbage on ridges or beds raised several inches above the level of the soil. In well-drained soil such practice will decrease the yield unless the season should be excessively wet. In the spring of 1895 three plots were prepared for cabbage, and well fertilized. The rows of one plot were ridged to the height of 8 inches, another to 4, and the third was made level. The seed for the test were sown in cold frame December 12, 1895, shifted to flats January 21, 1896, and transferred to the open February 28. The plants were carefully selected, all being practically of the same size, and were set so that the bud was just level with the surface of the ground. For three weeks after the transfer to the open the plants on the 8-inch-high beds grew more rapidly than the ones set without beds, and finally matured earlier, casting some of the lower leaves. As the three plots matured the cabbage were cut, the loose leaves removed and the heads weighed. The results are recorded below:

Number of Plants per Plot.	Variety Early Summer.	Number of Plants that Headed.	Average Weight per Head.	Total Weight.
			Lbs.	Lbs.
25	Ridge, 8 inches high	18	3	54
25	Ridge, 4 inches high	16	3¾	60
25	Level	20	5	100

DEEP VS. SHALLOW SETTING OF CABBAGE.

It has been observed that cabbage transplanted in private gardens are more frequently than otherwise set but little if any deeper than they grow in the seed bed. In the spring of 1896 three plots were planted, the plants being set at different depths. The seed were sown in a hotbed December 27, transferred to flats January 21, and to open February 28. One lot was set with the bud just level with the surface of the soil, another no deeper than the plants grew in the flats, and the third halfway between. The plants were 4 inches high, thus leaving the buds in one case 4 inches above the ground, 2 inches above in another, and level in another. The two plots set with the stems above the ground suffered to some extent from cut worms, while the other did not, further than the loss of a few leaves.

When harvested, the following results were recorded:

Number of Plants per Plot.	Variety, Stein's Flat Dutch.	Number of Plants that Headed.	Average Weight per Head.	Total Weight of Yield of Plot.
			Lbs.	Lbs.
25	Bud set level with surface of soil........	24	4¼	102
25	Halfway between	21	3¾	78¾
25	Set as plants grew in Plots................	16	2⅛	34

VARIETY TEST—CABBAGE.

Late in February, 1897, several varieties of cabbage were transplanted to light sandy but well fertilized soil, for the purpose of determining what varieties were best suited for early market. Beginning May 15, successive harvestings were made as marketable maturity was reached, and the average weight per head recorded as appears below:

	Average Weight May 15.	Average Weight May 22.	Average Weight June 1.	Average Weight June 10.	Average Weight June 22.	Per cent that Headed.
Early Varieties, 10 Plants Each.						
Cannonball	4.6	4.9	....	....	....	100
Winningstadt	3.2	5.2	....	....	....	80
Charleston Wakefield	4.8	4.8	....	....	....	100
Deep Head	5.3	7.0	....	....	....	100
Etampes	5.0	5.5	....	....	....	90
Express	3.2	3.5	....	....	....	100
Jersey Wakefield	5.5	7.5	....	....	....	100
Large York	3.3	3.8	....	....	....	80
Average	4.36	5.27	....	....	....	93.75
Medium Varieties, 10 Plants Each.						
All Head Early	....	....	6.0	6.5	....	90
All Seasons	....	6.2	3.2	....	....	90
All the Year Round	....	....	3.0	4.1	....	90
Buncomb	....	5.5	3.1	....	....	80
Dwarf York	....	2.8	3.0	....	....	50
Drumhead	....	8.7	5.0	....	....	100
Early Summer	....	5.5	2.5	....	....	100
Flat Dutch, Early	....	6.6	6.8	....	....	100
Flat Dutch, Late	....	6.0	4.0	....	....	100
Hollander	....	....	5.7	5.9	....	90
Safe Crop	....	....	3.0	3.2	....	80
Sure Head	....	5.7	2.7	....	....	90
Average	....	5.87	4.0	4.92	....	88.3
Late Varieties, 10 Plants Each.						
Fottler's Brunswick	....	....	....	3.0	3.0	90
Harvest Home	....	....	....	2.3	2.4	90
Large Late Flat Dutch	....	....	....	3.6	3.7	90
Luxemburgh	....	....	....	5.0	5.0	80
Marvin's Savoy	....	....	....	3.0	3.0	70
Peerless	....	....	....	4.6	4.7	80
Premium Flat Dutch	....	....	....	5.2	5.5	80
Stein's Flat Dutch	....	....	....	6.1	6.5	100
Stonemason	....	....	....	4.2	4.6	70
Vandergaw	....	....	....	4.3	4.2	90
Average	....	....	....	4.13	4.26	84

THE RELATIVE VIRULENCE FOR THE DOMESTIC ANIMALS OF HUMAN AND BOVINE TUBERCLE.

BY ROBERT R. DINWIDDIE, M. D.

PART I. BIBLIOGRAPHICAL REVIEW.

By the terms human and bovine tubercle—tuberculosis as it occurs in man and in cattle—a division of convenience only is implied. Although tuberculosis occurs in other species of domestic animals than cattle, and even in wild animals under confinement, these cases are comparatively rare. In so far as contagion is concerned, it may be presumed that mankind and cattle constitute the essential agents in the perpetuation and spread of the disease. It is frequently said that one out of every seven persons die from tuberculosis. Autopsical records show a much larger percentage than this affected with tubercular lesions. Of the numbers who at some period of their lives suffer from some form of tubercular disease and ultimately recover, we have practically no knowledge.

Among cattle, though the mortality from this disease is small, the percentage showing tubercular lesions on slaughter, although far less uniform in geographical distribution, is in many countries and in certain regions of this country apparently little inferior to that in mankind. Compared with these figures, the occurrence of tuberculosis in horses, pigs, sheep, dogs, and cats, becomes insignificant. Moreover, in these animals the records seem to show in nearly all cases an extraneous infection—dogs and cats from mankind; pigs from cattle. Human and bovine tuberculosis, on the contrary, possess some claim to a genealogical unity, each species receiving the contagion presumably from its own kind. This much may be assumed without prejudging the case, namely, that cattle in general receive the contagion of tuberculosis from each other rather than from mankind, in so far as the opportunities for infection in this way are decidedly greater. The history of cases of tuberculosis-infection in cattle where these are available, points to the same conclusion: there are many observations on record of infection of herds by the introduction of diseased animals, but hardly any worthy of consideration which point to an infection from man. The assumption of a genealogical unity for bovine tuberculosis in general is therefore justifiable, although not necessarily correct in all cases.

In the case of tuberculosis in man such an assumption, based upon the degree of exposure, is less justifiable on account of the universal use of milk which may supply a source of contagion when derived from tuberculous cows. In other words, man is more exposed to the contagion of bovine tuberculosis than are cattle to that of human tuberculosis. Pathologists, however, are almost unanimous in the belief that in the human race the principal mode of infection is from man to man.

There is in these facts some foundation for an hypothesis of a division of mammalian tuberculosis into two varieties etiologically distinct, the human and the bovine; of an evolution of races of tubercle bacilli, each parasitic especially in its own host-species, but possessing little aptitude for growth in the other.

The intertransmission of tuberculosis between mankind and cattle must depend upon two factors, namely, first, the virulence of tubercle bacilli of bovine tuberculosis for man and of those of human tuberculosis for cattle; and second, the degree of exposure to contagion between the two species. The latter of these influences may be estimated by observation of our relations with cattle generally and in relation to human infection has been made the subject of much research in the examination of meat and milk, but the former can be determined only by experimentation, an experimentation which in this instance is necessarily one-sided.

This question of the intertransmission of human and bovine tuberculosis possesses its greatest importance from the standpoint of hygiene. Is tuberculosis transmissible from cattle to man? If so, what proportion of our multiform tubercular ailments—phthisis, scrofula, arthritic disease, lupus, infantile diarrhœa, meningitis, etc., owe their origin to this source of infection? These questions remain for the future to answer.

From the agricultural standpoint we have to consider the opposite condition, namely, the possibility, and if this be shown, the relative frequency of the transference of the disease from man to cattle. This side of the question has an importance of its own, independent of what light it may throw upon the question of the etiological unity or duality of the human and bovine disease. Although we have assumed that cattle in the great majority of cases acquire the contagion from their own kind rather than from man, because of their more intimate cohabitation with each other, there is a possibility that the starting point of a general infection of a herd may have a human source. If cattle are readily susceptible to the action of the bacilli of human pulmonary consumption the opportunities for contagion of this kind must be frequently supplied by consumptive dairy attendants. The dried and pulverized expectorations of consumptives, considered to be the chief source of infection in man, it is permissible to suppose, may be an occasional source of infection also in the cow stable. Since the eradication of tuberculosis from the cattle on a farm is usually an expensive process, it becomes important to learn as far as possible all the methods by which the disease may be introduced. Whether or not cattle do at times obtain infection from man is a question on which we have practically no knowledge. That they are to a certain degree exposed to the contagion of human tuberculosis is unquestionable; whether or not this exposure may result in infection is another question and one on which the literature of tuberculosis throws but little light. We can hardly hope to obtain information on this point by ordinary observation in a disease so universal in its distribution and so insidious in its attacks as tuberculosis. The fact that such observations are hardly at all recorded in tuberculosis literature has, therefore, but little value in disproving the possibility of an occasional human origin of bovine infection.

The prevalence of tuberculosis in cattle, as in mankind, is undoubtedly dependent upon several factors—contagion, mode of life, and inherited constitution or *predisposition* as it is generally expressed. Without discussing here the relative importance of each of these influences, the fact may be noted that, under the conditions in which cattle are commonly kept, contagion from one diseased animal will in time give rise to a general infection of the others on the same farm. This fact is not any longer in dispute. The influence of contagion in the spread of tuberculosis is, in fact, better supported by observation of the disease in cattle than it is in the same disease in man.

An inquiry into the probabilities of an infection of cattle from man should include a consideration of the degree or extent of the exposure to contagion, the mode or form in which the contagion is supplied, and the susceptibility of cattle towards such contagion, all compared with the conditions which prevail in infection from animal to animal. An exhaustive discussion of the two former of these considerations is outside the range of this paper. A brief statement, however, of the views generally held by pathologists may with advantage be given here.

There is much yet to be learned both in the human and the bovine disease as to the modes by which contagion is effected and the gateway by which the bacilli gain entrance to the body. It is believed that in cattle as in man the bacilli are supplied chiefly by the discharges from the lungs, although in cattle such discharges are seldom abundant and have not been found to contain tubercle bacilli in numbers such as are found in the expectorations of human consumptives. It is, indeed, as is well known, rare that a finding of tubercle bacilli can be made in such nasal discharges as are obtainable from cattle, although I have myself seen one case in which the bacilli were as numerous in the profuse nasal discharge as I have ever found them in human sputa. In this exceptional case which shortly ended in death, a large tubercular abscess was found in the lung. It is probable that the bacilli are also discharged by the breath during coughing in the form of spray. Since most of the sputa in cattle seems to be swallowed it can hardly be doubted that the bowel discharges of tuberculous cows act as carriers and distributers of tubercle bacilli. On purely theoretical grounds there is reason in thinking that this may really be the principal way in which stables are infected, but no actual investigations of this matter seem to have been made. That tubercle bacilli may traverse the alimentary tract without losing their pathogenic activity has been established by several investigators. The inhalation of the dried and pulverized discharges containing tubercle bacilli, or their introduction with the food, results in a primary infection of the respiratory or alimentary tract. This is the mode in which infection is supposed to be brought about. Prolonged or repeated exposure, such as occurs in the cohabitation of cattle in stables, seems to be necessary for infection in most cases, although Chauveau has shown that a single feeding of calves with tubercular material may be sufficient.

The conditions of a problematical infection of cattle from human consumptives are not different from those above described, except in degree. The depositions of tuberculous human sputa on the floor of the cow stable are in this case comparatively infrequent, but the number of bacilli contained in the sputa usually very large as compared with those present in similar discharges from cattle. In both instances the bacilli are distributed in the same form, namely, in the morbid excretions of diseased lungs. On the whole it would seem that the amount of contagion supplied in this way may be sufficient to occasionally initiate tuberculosis in a herd of closely stabled dairy cows, assuming that the susceptibility of cattle is equally great for tubercle bacilli of human and of bovine origin. We can hardly be justified in assuming that this is the case without experimental evidence. The fact that bacilli of the same species (so far as our knowledge of species among the bacteria will allow us to judge) are present as causal agents in the lesions of human and bovine tuberculosis does not necessarily imply an absolute etiological identity of those diseases. It is conceivable that human and bovine tubercle bacilli may represent races of the same species differing from each other in their pathogenic activity, the one parasitic and pathogenic especially in man, the other in cattle.

It would seem that amidst the multitude of inoculation and other experiments in the artificial production of tuberculosis which have been made since the time of Villemin, sufficient evidence would be available to enable us to judge of this question. I have taken the pains to wade through the literature of tuberculosis, a library in itself, in order to glean from the record of these experiments whatever seemed to have any bearing on this subject and here present, as a prelude to certain experiments of my own in this line, a brief review of what seemed to me to be the most important. It may be said, in the first place, that but few experiments have been made with the object of testing the relative virulence of human and bovine tubercle towards the larger domestic animals. Most of the inoculation or feeding experiments prior to Koch's discovery of tubercle bacilli, published in 1882, were made with the view of testing the specific or contagious nature of tubercle in general. In most cases the infective material was obtained either from mankind or from cattle. In some few the records fail to show from what source it was obtained.

For those records published previous to 1885, the original articles scattered through many periodicals have been consulted in the files of the library of the Army Medical Museum at Washington. Since that date I have in many cases referred only to the reviews of bacteriological literature contained in Baumgarten's Yearbook, the Yearbook of Veterinary Medicine by Ellenberger and Shütz which dates back to 1881, and the Centralblatt für Bakteriologie.

In these instances in the list of references appended to this paper both the periodical containing the original article and the review consulted have been inserted.

For the purposes of this inquiry the inoculation experiments preceding those of Villemin (1865 *et seq.*) do not require review. This author (Villemin)[1] made an extensive series of inoculations of tuberculous material from man and from cattle to the domestic animals both large and small. Of his inoculations to guinea pigs and rabbits it need only be said that the results in both were generally positive, but that rabbits showed a greater susceptibility to bovine than to human tubercular material. "None of the rabbits inoculated with human tubercle gave so rapid and so completely generalized a tuberculosis as was obtained by inoculating them from the cow" (p. 538). Rabbits were infected in one test by inoculation with human scrofulous matter, in another test the result was negative. Fowls were found insusceptible to human tubercle. Nine cats subcutaneously inoculated with human tubercle gave negative results in five cases, in the others only slight lesions. In twelve dogs similarly inoculated the results are given as positive in three cases only, these showing generalized tuberculosis. Inoculations (presumably from the context subcutaneous) were made to ten sheep without in any case producing lesions resembling either human or bovine tuberculosis. Goats were also found refractory to human tubercle subcutaneously inoculated. From tubercle of cattle one inoculation was made to a lamb which died tuberculous in five weeks.

Chauveau[2] (1868) fed to three calves, two, ten, and six months old, a quantity of semi-putrid tuberculous material obtained from cattle. One of these obtained only one dose, the others received a second dose eighteen days later. In about three weeks coughing and glandular enlargement appeared. In seven to eight weeks they were all in very poor condition and two were killed. The autopsy showed ulceration of the intestine and infection of the mesenteric, bronchial, and mediastinal glands. The lungs were full of tuberculous masses. All three of the calves were infected.

Three pigs, six to twelve months old, drenched with pieces of the diseased lungs of a tuberculous cow broken up in water, showed at the autopsy, in fifty-two days, tubercular infection involving the intestines, mesenteric glands, lungs, and glands of the neck.

Similar experiments are described in a later communication[3] (1873). Two calves were fed four times at a few days interval with ten to forty grams each of tubercle from the lungs of cows. The autopsy showed enlargement and caseation of the submaxillary, precervical, retropharyngeal, mediastinal, and mesenteric lymph glands, with hypertrophy of Peyer's patches.

These experiments by Chauveau, made for the purpose of testing the transmissibility of tuberculosis to cattle by feeding, are supplemented by others[4] in which comparative tests were made also on calves of the action of human and bovine tubercle, with a view of establishing the identity of the disease in man and cattle. Although made, apparently, about 1870, the detailed publication of these tests only appears in 1891. Three calves of six, eleven, and eight months, were fed with pieces of human lung affected with miliary tubercle or with chronic phthisis. The material was given, broken up in water, by drenching each on two occasions on the same or successive days. Killed at the end of fifty-seven, fifty-nine, and thirty-four days, respectively, these three animals presented rather extensive tubercular lesions. No. 1 showed over 200 tubercular nodules reaching to the size of a pea, scattered over the mucous membrane of the small intestines, tubercles in the walls of the colon and stomach, tuberculous masses in the liver, and an eruption of young tubercles throughout the peritoneum. No. 2 showed walnut-sized masses scattered through the lungs with involvement of the bronchial, submaxillary and pharyngeal lymph nodes; very slight abdominal lesions. In No. 3 was found an eruption of small tubercles in the mucosa of the small intestine, a tubercular nodule in the lung, and small gray tubercles in the mucosa of the larynx and upper part of the trachea. The results, in the three animals fed with bovine tubercle, are said to have been almost identical with the above.

Subcutaneous inoculations from human tubercular arthritic disease and from acute miliary tuberculosis to seven calves gave only local lesions and involvement of the nearest lymph nodes, a result similar to that obtained by the inoculation of bovine tubercle. The author states that "human tubercular virus reacts towards the bovine species exactly like tubercular virus coming from cattle," and claims for these experiments the first complete experimental demonstration of the identity of the human and bovine disease.

Gerlach[5] inoculated a three months old calf in the subcuta with crushed tubercular nodules from a cow. The finding at the autopsy five months later consisted of four enlarged and caseous lymph nodes near the place of inoculation but no other lesions. A goat one year old similarly treated developed a local and an extensive lung infection.

The author states that the results are similar to those produced by inoculation of human tubercle but the local reaction is greater.

Positive results were also obtained in calves, pigs, and sheep, by feeding them with milk from tuberculous cows, and in one pig (involving the mesenteric and bronchial glands) by feeding once with nodules from the serous membrane of a cow. A dog fed in this way did not become infected.

An experiment frequently referred to in German tuberculosis literature is that of Klebs.[6] He inoculated (1869) a healthy four weeks old calf in the abdominal cavity with human tubercular material (the source of which is not further revealed) rubbed up in water. Fifteen syringefuls were injected on July 16. On October 22 the animal was killed and showed over the whole omentum and part of the stomach wall a large number of calcareous nodules histologically similar to those of Perlsucht; in addition there were found gray miliary tubercles in the mesenteric glands, diaphragm, and liver, and flattened gray tubercular projections (flachvorragende Tuberkeln) on the surface of the spleen. Klebs, who attributes human tuberculosis largely to infection from cattle, makes the following statements: "Tuberculosis of cattle is identical with Perlsucht, or the new formations in the latter show only a special development of tubercles which correspond in all respects with the so-called fibrous tubercles of man and are distinguished from the common miliary form only by the development of abundant fibrous tissue.

"Perlsucht (fibrous tuberculosis) of cattle owes its origin to the same virus as human tuberculosis."

Bagge[7] (1870) inoculated subcutaneously two calves, nine, and twenty-one months old, from a human lung affected with miliary tuberculosis. After four and a half months both were killed and found free from tubercles. In the older animal there was a local abscess. A second experiment was made, also on two calves, with the tuberculous lungs and bronchial glands of cattle. Combined feeding and subcutaneous inoculation resulted in infection in both cases, the lesions being found locally and in the lungs, pleura, bronchial and mesenteric glands.

A transference of tuberculosis from cattle to the dog by feeding is reported by Scholtz,[8] the disease involving the lungs, bronchial and mesenteric glands; and to the dog and the cat by Viseur.[9] In the latter case, besides abdominal lesions, miliary tubercles were found in the lungs.

Bollinger[10] (1873) with human sputum obtained negative results in three cats by inoculating them in the lung and in one dog inoculated in the trachea a local enlargement only. A dog inoculated in the lung with the juice of a tuberculous human lung developed tuberculosis involving most of the internal organs.

With bovine tubercle the following tests were made: Two goats inoculated in the peritoneal cavity showed on dissection miliary tuberculosis of the liver and of the whole peritoneum, adhesive peritonitis, and enlarged glands. One of these animals died in eighteen days, the other was killed on the forty-third day. One dog inoculated in the subcuta and killed in thirty days gave a local enlargement only. Four dogs, two goats, and two sheep, were fed with tuberculous lungs of cattle with resulting infection in one sheep and both goats and a negative result in the other animals.

This article contains a partial review of the feeding tests on the larger animals made previous to that time. Of these the following have not been noted elsewhere: Of two swine fed with human tubercle one showed a swelling of the bowel follicles and enlargement with caseous and calcareous degeneration of the mesenteric glands; the other was not infected. Three swine fed with tubercles of bovine source (from artificially infected sheep) developed a pronounced general tuberculosis (Bericht über das Veterinärwesen in Königreich Sachsen f. das Jahr 1870, s. 150; Ibidem, 1871, s. 144).

In 1894 Bollinger communicated an experiment of his[11] made in 1879 and hitherto unpublished. A three months old healthy calf was inoculated in the peritoneal cavity with tuberculous fluid from a human lung. Seven months later, at the post-mortem examination, a characteristic abdominal Perlsucht was found whilst the thoracic organs were normal.

Flemming,[12] in a review of the experiments on the transmissibility of tuberculosis, gives the following feeding test of which the original communication has not been seen: Liesering, of the Dresden Veterinary School, fed two sheep for three days on the tuberculous lymph glands of a cow. One was killed on the eighty-fifth day and found to have ulcers of the intestine with small tubercular tumors, mesenteric glands tuberculous, liver and lungs full of tubercles and in the latter the largest masses were already calcified. The other sheep was also infected.

Blumberg[13] (1879) fed eight sheep with sputa and tuberculous human lung. In seven cases there was resulting disease in the intestine (Peyer's plaques) and occasionally also tubercles of the liver, spleen, mesenteric glands, pleura, or lungs. In later experiments[14] he also obtained infection of pigs with human sputa.

Creighton,[15] chiefly on histological grounds, doubts the identity of Perlsucht with the ordinary forms of human tuberculosis. He describes a number of cases in man which presented features recalling the bovine disease, chiefly in their involvement of the serous membranes and lymph glands. Scrofula, he looks upon as bovine tubercle in man.

Pütz[16] refers to Klebs's experiment as the only one really showing a production of Perlsucht by inoculation of human tuberculosis, and finds an objection to this one in the fact that the experimenter had no knowledge of the parents of his experimental calf which may, therefore, have been affected with hereditary or earlier acquired tuberculosis. He communicates the following experiments of his own: A calf was fed, during ninety-seven days, with seven tuberculous lungs from man, with entirely negative results at the autopsy made in 170 days. Two calves, of four weeks, and ten months, received an injection of an emulsion of human tubercle in the abdominal cavity, one also receiving a second injection in the lung from another specimen of human tubercle. In both cases a local abscess formed in the abdominal wall; in one there was, in addition, a development of short fibrous threads around the place of inoculation in the peritoneum. No miliary tubercles or "Perlknoten" were found. In the horse he produced an acute development of miliary tubercles by inoculating human tubercle in the lung. In a later experiment[17] (1883) two calves received an injection of tubercle bacilli containing material from the lung of a human consumptive. One was killed in 186 days, and no lesions of tuberculosis found; the autopsy on the other is not recorded.

Commenting on the transmissibility of tuberculosis between mankind and cattle, Pütz advances the view that each zoölogical species possesses the greatest susceptibility to the tubercular virus from its own species, and sometimes but little susceptibility to that from other species. "A susceptibility of cattle for the tuberculosis poison of man, and of the latter for the Perlsucht poison of cattle, is not shown by any observations which are entirely free from objections."

In his own experiments the results were always negative in bringing about in calves a typical Perlsucht with human tubercular material, but positive in producing a local development of tubercles containing the specific bacilli—lesions no more representative of the typical tuberculosis of cattle than are the vaccination pustules representative of variola proper. ("So wenig aber eine Vaccinepustel des Menschen die eigentliche Blatternkrankheit reprasentirt, ebenso wenig reprasentiren tuberkelbacillenhaltige Impfknötchen in Folge von Uebertragung tuberculösen materials vom Menschen auf das Rind mit absoluter Nothwendigkeit eine typische Tuberculose oder Perlsucht.") Pütz, therefore, considers it not proven that the tuberculosis of man is a source of Perlsucht of cattle, and the bovine disease a source of infection for man.

Kitt[18] injected into the peritoneal cavity of a calf twenty grams of a suspension in water of material from a tuberculous submaxillary gland of man. It died in forty-six days. Dissection showed tuberculous inflammation of parietal and visceral layers of the peritoneum, pericardium and both pleuræ, tuberculous degeneration of the bronchial glands, and œdema of the lungs.

Toussaint,[19] with the aim of showing the contagious nature of tuberculosis, made numerous inoculations from cattle, chiefly to rabbits, swine, and cats, and his experiments show the virulence of bovine tubercle for these animals, both by subcutaneous inoculation and feeding.

Siedamgrotzky[20] made a test of the action of tuberculous material from man and cattle on fourteen sheep and seven pigs. It is stated that no constant results were obtained. However, the sheep fed with human tubercle remained unaffected whilst those receiving bovine tubercle showed generally tuberculosis involving the mesenteric glands, intestine, and other organs.

Klein and Gibbes[21] (1883) dispute the identity of human and bovine tuberculosis, basing their opinion on differences which they observed in the morphology of the bacilli from the two sources and on the lesser virulence of human tubercle bacilli for rabbits. "Although guinea pigs are infected both by bovine and by human tubercular matter they are more susceptible to human than to bovine tubercle. Rabbits, on the other hand, show a very much greater susceptibility to bovine than to human tubercle; whether fed or inoculated with human tubercular matter the result was much the same; the lungs were the only organs affected and there was a great scarcity of tubercle bacilli; but bovine tubercular matter always produces in them general tuberculosis with abundance of bacilli." The authors conclude "that the tubercular virus derived from the human subject is not exactly the same as that derived from the tuberculous cow.''

Johne,[22] in a review of tuberculosis infection experiments, refers to one of Bollinger: A young goat received in the peritoneum sixty grams of a fluid obtained by rubbing a particle of a scrofulo-tuberculous (tuberculos-scrofulösen) lymph gland from man in normal salt solution. A positive result was obtained, the lesions resembling those found in Klebs's similar experiment with a calf.

Tests of inoculation of horses and dogs from cattle (Köhne), and of mules, sheep, a cow and dog (Verga), are also mentioned, all with negative results.

Semmer[23] fed and inoculated bovine tubercle to a dog with, as result, a tubercular disease of the serous membranes, lungs, liver, and mesenteric and bronchial glands. A goat, also, inoculated with bovine tubercle gave a disease resembling Perlsucht. He finds grounds in his researches for a subdivision of mammalian tuberculosis into two varieties — miliary tuberculosis of man and some mammals, and Perlsucht of cattle.

Baumgarten[24] makes brief mention of inoculation of calves (presumably from the context intra-ocular) with cultures of human tubercle bacilli with, as result, only a local effect. This he ascribes to a lack of virulence of the bacilli. On the other hand intra-ocular inoculation from the nodules of Perlsucht occasioned a typical local eye tuberculosis followed by a generalized disease showing all the gross and microscopical characters of acute miliary tuberculosis of man, thus, as he says, filling a gap in the evidence as to the identity of tuberculosis and Perlsucht.

Crookshank[25] (1891) inoculated a calf in the peritoneal cavity with sputum from an advanced case of phthisis. Death occurred in forty-two days and the post-mortem examination revealed peritonitis with adhesions, tubercular deposits, and a walnut-sized abscess at the seat of inoculation, numerous wart-like fleshy growths on the mesentery, diaphragm, and surface of liver and spleen, and microscopic tubercles containing tubercle bacilli in lungs and liver—a case of streptococcus infection and generalized miliary tuberculosis.

Frothingham[26] (1897) made a number of tests of the action of cultures of human tubercle bacilli and of sputum of phthisis on calves. With cultures four calves from three weeks to three months old were injected, two in the abdominal cavity and two in the trachea. After five weeks all gave a tuberculosis reaction to tuberculin. Of those inoculated in the abdominal cavity, one, killed at the end of six weeks, showed several pea-sized nodules on the stomach, intestines and mesentery, and a number of minute nodules on the parietal surface of the peritoneum and surface of spleen; the other (after five months) showed numerous nodules, mostly minute, scattered over the omentum, and caseous tubercles in the mesenteric glands. One calf inoculated in the trachea and examined after five months was found free from all tubercular lesions; the other showed local lesions and several small tubercles in the lungs and beneath the capsule of the liver.

Of the sputum tests one calf inoculated subcutaneously presented no changes referable to the inoculation; two others receiving the injection into the trachea showed a local development of tubercles and caseous masses outside the trachea with in one case slight superficial lesions in the liver of doubtfully tubercular nature.

The author concludes "that calves are apparently not particularly susceptible to the human tubercle bacillus."

Th. Smith[27] (1896), on comparing cultures of tubercle bacilli obtained from man and from cattle, observed morphological and cultural differences which were constant in sub-cultures kept under the same conditions. The cultures of bovine origin possessed greater pathogenic activity than those from man for both guinea pigs and rabbits. Two cattle, one year, and two and a half years old, inoculated in the lung with a culture of human origin, were found free from tubercular changes when killed three months, and fifty-four days, respectively, after inoculation.

Another, two and a half years old, similarly inoculated with a culture of bovine tubercle bacilli, died in five weeks of acute tuberculosis. Besides extensive disease of the thoracic cavity, tubercles were present in the kidneys and liver, and necrotic foci in all the lymphatic glands.

A repetition of these tests on a larger scale was made in 1897,[28] ten cattle being inoculated with as many different cultures of tubercle bacilli, half of human and half of bovine origin. Adult cattle, in general, were employed and the injections made in the lung. The report gives a detailed description of the post-mortem findings in each case. A comparative study of the histological structure of the lesions induced by the human and bovine bacilli was also made. The results were similar to those obtained in his previous experiment and indicate a much greater susceptibility of cattle for bovine tubercle bacilli in artificial cultures than for those of human origin. The lesions produced by the inoculation of human tubercle bacilli consisted in an abscess at the place of inoculation in the lung, in the pleura of the same side a formation of vascular fringes and flattened pedunculated masses histologically unlike tubercles. The inoculation of bovine tubercle bacilli produced disseminated tuberculosis of the lungs, pericardium, diaphragm and ribs, and involvement of the lymph glands of the thorax; in a few cases slight tuberculosis of the abdominal organs.

The number of cultures and animals employed in these experiments and the fact that all the details necessary for making the test a comparative one were carefully attended to seem to justify the conclusion that the human and bovine bacilli in general represent races of unequal pathogenic activity for cattle. On the practical question of the inter-transmission of the human and bovine disease the author thinks it improbable that under natural conditions cattle can become infected by human tubercular sputum, whilst on the other hand "accepting the clinical evidence on hand, bovine tuberculosis may be transmitted to children when the body is overpowered by large numbers of bacilli, as in udder tuberculosis or when certain unknown favorable conditions exist."

This article gives a review of an experiment by Sidney Martin (Rep. Roy. Com. on Tuberculosis, 1895, Appendix, p. 18), of which I have seen nothing elsewhere: Four calves fed once with bovine tubercle in large quantity gave positive results with lesions involving the lungs and pleura, as well as the intestine and mesenteric glands. In six others fed once with sputa of man, also in large amount, nodules of the intestine were present in four, of which one also showed infection of the mesenteric glands. Two were free from lesions.

The conclusion arrived at was that sputum was less infective for calves than bovine tubercle.

The foregoing review does not include all the tests which have been made in transmitting tuberculosis to the domesticated animals. I have omitted, as aside from the subject under consideration, all experiments bearing on the reciprocal transference of avian and mammalian tuberculosis, as well as those dealing with the ordinary laboratory animals—guinea pigs and rabbits. For the same reason are excluded many feeding tests on the larger animals attended with negative results, and others showing the transmission of tuberculosis from cattle to other ruminants and to swine by feeding the milk of diseased cows. The literature of tuberculosis also contains many observations (unconnected with experiments) not recorded here indicative more or less clearly of a natural transmission between animals of different species and between mankind and animals. Some of these are almost as convincing as experimental evidence, those, for instance, showing the infection of cats and dogs by eating the sputa of their consumptive owners, and the infection of pigs by feeding on the tubercle-bacilli-containing milk of diseased cows, while others for various reasons have but little value.

Wesener[29] in a critical review of the experiments on ingestion tuberculosis made up to that time (1885), makes a summary from which the following may be extracted as bearing on our subject: Of the animals (71) on which feeding experiments with human tubercular material were undertaken, guinea pigs and swine were most easily infected. On cattle the effects could hardly be estimated, as only two tests were made—one with positive the other with negative results.*

Sheep became infected in half the cases;† dogs very rarely.

Of the cases (180) in which feeding tests of animal tuberculosis (chiefly bovine) were made, calves, goats and sheep showed the greatest susceptibility—a positive result in about three-fourths of the cases; pigs in two-fifths; cats in over, and dogs under, one-third. On account of the varying number of the animals of the different species used, very much importance cannot be attached to these figures as showing the comparative susceptibility of animals toward human and bovine tubercle.

---

*Wesener's review does not include the feeding experiments of Chauveau made before that time but not fully published till 1891.

†The tests on swine and on sheep (as well as on cattle) were too few to furnish reliable data for any opinion.

The attempt to summarize the facts reported in the foregoing review and to deduce conclusions therefrom, is perhaps best postponed until after the description of my own experiments which forms the subject of the second part of this paper.

LIST OF REFERENCES.

1. Villemin. Gaz. hebd. de Med., Paris, 1865, II, p. 795; Ibid., 1866, III, p. 758; Ibid., 1867, IV, p. 458. Études sur la tuberculose, Paris, 1868.

2. Chauveau. Bul. de l'Acad. de Med., 1868, p. 1007; Rec. de Méd. Vétér. 1869, p. 202.

3. Chauveau. Assoc. franc. pour l'avance de Sc., Compt. rend., 1873, p. 717.

4. Chauveau. Congrès. pour l'étude de la tuberculose, 1891, p. 51.

5. Gerlach. Jahresbericht der Königlichen Thierarzneischule zu Hanover, 1870.

6. Klebs. Archiv. für path. Anat. u. Physiol., Bd. 49, 1870, p. 292.

7. Bagge. Rep. d. Thierhlk. v. Herring, Bd. 31, 32, 1870, 1871.

8. Scholtz. Mittheilungen aus der thierarztl. Praxis im Preuss. Statte, 21; Jahrg. f. d. J. 1872, 1873, S. 116.

9. Viseur. Bul. de l'Acad. de Med., No. 37, p. 891.

10. Bollinger. Arch. f. exper. Path. u. Phar., 1873, I. p. 356.

11. Bollinger. Münch. med. Wochenschr., 1894, No. 5 (Baumgarten's Jahresbericht, 1894, p. 714).

12. Flemming. Brit. and Foreign Med. Chir. Rev., Vol. LIV. 1874, p. 461.

13. Blumberg. D. Zeitschr. f. Thiermed., Bd. V, S. 319 (Wesener. Fütterungstuberculose, p. 16).

14. Blumberg. (Jahresbericht Vet. Med., 1885.)

15. Creighton. Jour. Anat. and Physiol., 1880, 1881, XV, p. 1.

16. Pütz. Versammlung deutsche Naturforscher in Eisenbach, 1882. Wiener Mediz. Blaetter, No. 41.

17. Pütz. Deutsche Med. Ztg., 1884, I, S. 557.

18. Kitt. Münch. Jahresbericht, 1881, S. 28 (Jahresber. Vet. Med., 1881, S. 44).

19. Toussaint. Compt. rend., Tome 93, No. 5, p. 281 (Jahresber. Vet. Med., 1881, S. 45).

20. Siedamgrotzky. Berl. Arch., VIII, S. 174 (Jahresber. Vet. Med., 1882, S. 34).

21. Klein and Gibbes. Rep. Med. loc. Gov. Bd., London, 1883, 1884, 1885.

22. Johne. Deutsche Zeitschr. f. Thiermed., 1883, IX, Nos. 1, 2.

23. Semmer. Koch's Monatsschrift, Bd. XVIII, 1893, S. 193.

24. Baumgarten. Jahresber. pathogenen Mikroorganismen, 1891, p. 666.

25. Crookshank. Trans. Pathol. Society, Vol. XLII, 1891, p. 330 (Text-book of Bacteriology, 4th Ed., 1897, p. 390).

26. Frothingham. Rep. Mass. Cattle Commissioners, 1897, p. 50.

27. Smith. Twelfth and Thirteenth An. Rep. U. S. Bureau of Animal Industry, 1895, 1896, p. 149 (also in Trans. Assoc. Amer. Physicians, XI, 1896).

28. Smith. Jour. Exper. Medicine, III, Nos. 4, 5, 1898, p. 451.

29. Wesener. Fütterungstuberculose, p. 24; Freiburg i. B., 1885.

PART II. EXPERIMENTAL RESEARCHES.

Since the introduction of tuberculin as a diagnostic agent in tuberculosis of cattle and the consequent discovery of the general occurrence of this disease in many of the finest and most highly prized herds where it hitherto had not been suspected, the methods by which it may be combated have received considerable attention and discussion. The "stamping out" process, one feature of which requires the slaughter of all infected animals, has been voluntarily employed in individual cases with the result, sometimes, of not only stamping out the disease but practically extinguishing the herd as well. As a compulsory measure of general application an objection to its employment has been found in the enormous expense required for its execution, and, further, in the uncertainty as to the results. One element of uncertainty is presented by our limited knowledge, other than speculative, of the relation between the human and the bovine disease.

Before beginning my experiments in 1896 I was surprised in looking over the literature of tuberculosis for evidence of the transmissibility of the disease from man to cattle to find a total absence of any experiments or

AGRICULTURAL
LIBRARY,
UNIVERSITY
OF
CALIFORNIA.

observations on this point in the reference works at my command. From the time of Koch's discovery of tubercle bacilli practically nothing had, in fact, been done to elucidate this point. That discovery seemed to have been accepted by pathologists as establishing the complete identity and, therefore, transferability of the disease in man and animals. The literature previous to that date, however, as may be seen in the preceding review, contains the records of many experiments bearing on this question. In the last two years, also, several important contributions have been made, notably by Smith and Frothingham.

My own experiments were begun by testing the susceptibility of cattle towards human sputa with the aim of arriving at some opinion as to their liability to suffer from a spontaneous or natural infection of this kind. The results of these first attempts were so inconclusive that the work was continued later and extended to include comparative tests with bovine tubercular material also. In a few instances cultures of tubercle bacilli were employed. The animals on which the tests have been made include twenty calves, sixteen pigs, two sheep and sixteen chickens, guinea pigs and rabbits being also incidentally employed. In the case of five of these animals (calves) a partial record only is given, the experiment being still incomplete. In all cases the experimental animals were kept in rather large pens. A covered shed open at the sides was the only shelter they received, hence the influence of stabling with its constant attendant—defective ventilation—is excluded. On the other hand, some of the animals were exposed to the depressing influence of extreme winter weather. They were all liberally fed. The various pens were separated from each other by a space of about twelve feet and each supplied with independent drinking troughs.

Feeding experiments with tuberculous human sputa. This material was obtained in considerable amounts from a hospital for consumptives, and hence was usually the mixed products from many patients and from two to three days old when received. A relatively small quantity was received from other sources and used while still fresh. The presence of tubercle bacilli was verified in all samples before being fed, and in a few cases in which putridity was somewhat advanced the material was further tested by the inoculation of guinea pigs. These inoculations never failed to produce the usual result—a generalized tuberculosis—and hence need not be further referred to. In order to approximate more closely to the conditions of a natural infection the plan was adopted of feeding the material in small doses frequently repeated. It is possible that this may have influenced the result. In the experiments of the same kind by others it is noticed that the opposite plan was usually pursued, namely, administering the material on one or two occasions only and in larger quantity than I used.

The animals employed in this first experiment were four cattle, six pigs, and six chickens.

The *cattle* consisted of two calves, each two months old, in one pen, and two larger animals, nearly two years old, in another. It was the original intention to make on these older cattle tests of inhalation of dried and pulverized sputa, but this plan proved to be impracticable under the circumstances. They were fed, however, in a slightly different way from the other two. To the latter the sputum was given well mixed in milk during the first few weeks, after that in a mixture of milk and bran. The other lot got it in their feed boxes mixed with dry bran, a method which, from the drying of part of the sputa in the boxes, doubtless made the test to a certain extent one of inhalation as well as ingestion. All the cattle came from the same farm. A preliminary tuberculin test made on one of them proved negative..

The notes of these experiments show that altogether 526 C.C. of sputa were fed to these four cattle in twenty-four doses, the minimum at one feeding being 10 C.C., the maximum 60 C.C., and that the period of feeding extended through three months, August, September, and October, 1896. Fourteen samples of sputa were used, most of these being, as above stated, mixed samples, that is, not from one individual only. Tubercle bacilli were present in all and usually numerous. On December 29 all were tested with tuberculin and failed to give any reaction indicative of infection. The two older animals (A and B) were again tested March 11, 1897, with negative results. All were killed on March 18, about eight months from the beginning of the experiment, and proved to be entirely free from tubercular lesions.

The six *pigs* of this experiment were about six weeks old and received the sputa to the amount of 150 C.C. well mixed in milk. It was given in twenty doses from July 7, to October 7, 1896. The pigs were killed in May of the following year (1897), about ten months after the experiment began. The examination revealed slight lesions of tuberculosis in two animals only. In one of these there was enlargement and caseation of the submaxillary lymph glands, and a few of the mesenteric glands contained purulent foci. In these lesions tubercle bacilli were present in small numbers. The other showed enlargement of the submaxillary lymph gland of one side with formation of small pockets containing thick calcareous pus. Sections of this gland showed tubercle bacilli numerously present in the walls of these cavities.

The other four pigs were free from all tubercular disease.

The *chickens* subjected to this feeding test were six in number and about three months old. They received a total of 150 C.C. sputa in their food, in nine doses, during October, 1896. Killed December 21, none of these showed tubercular disease.

Tests of inoculation of human and bovine tubercle in parallel series were made on eight calves and four pigs. The inoculations were made in the peritoneal cavity in all of these animals, but two calves had previously received an injection in the trachea. There were used for these inoculations, four samples each of human and bovine tubercular material, one calf being inoculated from each specimen. The tests being intended as comparative ones may be most suitably described so as to illustrate this point, that is, as four separate experiments, although in the matter of dates the comparison is not always exact. The tubercular material of human origin was in each case the expectoration of pulmonary tuberculosis; that of bovine origin the nearest obtainable analogue to this, namely: the caseous degenerated material of tuberculous lungs or lymph glands of the thoracic cavity, which, for convenience, is designated "Bovine Virus" I, II, etc.

TEST 1. Sputum I, from a young colored female, a sufferer for at least one year, died about six months later; two sisters have already succumbed to the same disease; parents well; expectoration abundant, thick, purulent; tubercle bacilli numerous and often in groups; staining usually homogeneous; a few oval bacteria also present; no coccus forms.

February 17, 1898 (Pen I), calf E, one year old, grade Jersey, tested with tuberculin without reaction. February 25, it received in the trachea by large hypodermic syringe 1 C.C. of Sputum I (fresh), well mixed with three parts of sterile water. On same date, calf F (Pen I), three months old, common stock, which had also failed to react to tuberculin test, received 0.5 C.C. of Sputum I, in 6 C.C. sterile water in the peritoneal cavity. The injection in this and in all the other intra-abdominal inoculations was made with a large (veterinary) hypodermic syringe, provided with a trocar and canula attachment. The latter was thrust carefully through the abdominal wall in the hypogastric region, the trocar withdrawn, and the canula then pushed home. The free motion of the end of the canula, and the absence of escaping gas or fluid was taken as evidence that no penetration of the bowel had occurred.

Bovine Virus I* consisted of a substance looking like inspissated pus, of the consistence of butter, containing calcareous granules occupying a cavity in a bronchial or mediastinal lymph gland of a tuberculous steer. Microscopically, it consisted of an unorganized debris containing enormous numbers of short, solidly staining tubercle bacilli generally in groups, and unmixed with other bacteria. The diseased specimens received consisted of pieces of liver, lung, and glands, all containing large caseous and calcareous masses but showing few small or recent tubercles and few tubercle bacilli except in the material above mentioned. For inoculation the latter was mixed with eight or ten parts sterile water and passed through cheese cloth, thus giving a dilution in which tubercle bacilli were present in numbers equivalent to that of Sputum I.

---

*For all these specimens of bovine tubercle used, I am indebted to the government cattle inspectors at Chicago, St. Louis, and Kansas City.

March 14, 1898, calf G (Pen II), large, six months old, common stock, negative reaction to tuberculin, received 1 C.C. of above in trachea.

On same date, calf H (Pen II), three months old, also previously tested with tuberculin, received 1 C.C. in the peritoneal cavity.

Guinea pigs (15 and 16), inoculated at the same time as the cattle with sputum and bovine material, respectively, and killed nine weeks later, both showed a similar condition of general tuberculosis. (From these guinea pigs the cultures were obtained which were used in another experiment to be described later.)

On May 13 all were tested with tuberculin. The result of the test is shown in the table of thermometric readings on page 76. Calves E and H gave the reaction of tuberculosis, while F and G did not. A second test, made June 24 (Table II, p. 77), showed no distinct reaction in any case, although the temperature readings in F and H are high, both before and after injection.

Calves F and H were killed for examination on June 28.

Calf F (four months after inoculation in peritoneum with sputum) showed no trace of disease anywhere. The peritoneum was clear throughout, and the place of inoculation not recognizable.

Calf H (three and a half months after inoculation in peritoneum with bovine tubercle) showed the following lesions: The skin is difficult of removal (hidebound). Omentum thickened, and covered with hundreds of yellow and flesh-colored excrescences from the size of a pea to that of a filbert. They are present, less numerously, on the parietal peritoneum and on the surface of the rumen and diaphragm. Most of these growths are loosely attached by connective tissue to the surface, from which they spring. Their surface is rough from small seed-like prominences and on sections similar calcareous foci are found scattered through their substance. In places where a number of growths are confluent, forming masses an inch or more across, the picture is one of a typical "grape disease." There is no fluid peritoneal effusion. The intestines and most of the mesenteric lymph glands are normal. Those of the stomach and a few of those lying between the folds of the large intestine are caseous and calcareous. The other abdominal organs are normal. In the thoracic cavity the only lesions found are a few smaller growths on the surface of the diaphragm.

Tubercle bacilli were demonstrated in small number in sections of above lesions.

Calves E and G were not killed at this time but used later for intra-peritoneal inoculation of similar material. In order to avoid repetition of the post-mortem details this experiment may be given here, although not in chronological order.

These calves (E and G) were again tested with tuberculin on November 3 and again failed to react (Table IV, p. 79).

Test 2. Sputum III was originally derived from a youth in the early stage of pulmonary tuberculosis with a family history pointing to predisposition. The later history of this case is unknown. Tubercle bacilli were numerously present along with coccus and other forms. A guinea pig inoculated with this sputum died in three months with extensive tubercular lesions. The inguinal glands near the place of inoculation were converted into sacs containing a thick pus in which were numerous long and short granular tubercle bacilli. This formed the material called Sputum III.

February 11, 1899, calf E received in the peritoneal cavity a syringeful (about 7 C.C.) of a suspension in sterile water of above Sputum III. A loop of this suspension showed several dozen tubercle bacilli.

Bovine Virus III, received from the meat inspection office, East St. Louis stockyards, without description, consisted of grape-like bunches attached apparently to part of the peritoneum or pleura. On section these growths appeared largely fibrous, with yellow points and larger areas of less firm consistence. There were no purulent foci nor recent tubercles and no evident calcification. Pieces detached from the cut surface, teased and spread out on cover glasses afforded a sparse demonstration of tubercle bacilli along with a few putrefactive organisms. For inoculation pieces equalling together about the size of a pea were cut from a number of these growths, thoroughly broken up in sterile water, and the whole injected without straining. As regards the number of bacilli, the dose in this case was small.

December 31, 1898, calf G (Pen II) received above injection in the peritoneal cavity. A small guinea pig subcutaneously inoculated with 0.3 C.C. of the same was found dead one month later, and on dissection showed tubercular lesions locally, and in spleen and liver; none in lungs. (Death was due in this case mainly to exposure to extreme cold.)

The tuberculin test was applied to both the calves on February 22 (Table V, p. 80), and again on April 17 (Table VI, p. 81), with a negative result on both occasions.

Calf E was killed on May 17, about three and a half months after the last inoculation. The dissection revealed only insignificant changes. On the surface of the lungs and on the costal pleura are a few small roughened patches of a reddish color indicative of a recent pleuritis of slight extent. There is nothing to show that these are tubercular in nature. Bronchial, mediastinal and cervical lymph glands are normal, and there is no trace of the place of first inoculation in the neck. The great omentum, also, on part of its extent shows rough red patches with slight fringe formation, and about half a dozen small seedlike nodules are also present. On the surface of the liver are a few small white spots. The abdominal lymphatic glands and other viscera are normal. In this animal there is nothing to naked eye inspection which would give rise to a suspicion of tuberculosis.

Calf G was killed on May 8, a little over five months after the last inoculation. The autopsy notes follow: In the neck behind and at the side of the trachea are four or five abscesses containing thick yellow pus without calcification. The largest of these is about the size of a pigeon's egg. The trachea and cervical lymph glands are normal. There are some rough patches on the pleura costalis and pulmonalis, with traces of adhesions. Lungs and bronchial and mediastinal glands are normal. The peritoneal cavity contains a little yellow slightly turbid fluid without odor. On the peritoneal folds connecting the large intestines are a number of small fringes and one flat polypoid growth about the size of a split pea, calcareous in its center. On the abdominal surface of the diaphragm are many small seed-like excrescences and reddish colored fringes, the latter being also present in small number on the surface of the pyloric division of the stomach. The surface of the spleen is studded with grayish, tongue-like projections, the largest not reaching the size of a linseed; most of them are not larger than a pin head. They are superficial only, are firmly attached to the capsule and of a tough fibrous structure without evident calcification or softening in the center. The same excrescences are present, less closely set, however, on part of the surface of the liver. The parietal surface of the peritoneum is clean, and no trace remains of the place of inoculation. The walls of the small intestine (ileum) contain numerous nests of entozoa (Oesophagostoma). A few of these nests are also found in the substance of the liver and one in a mesenteric gland. None of the lymph glands are tuberculous. Although the abscesses in the neck (at the seat of inoculation made fourteen months before) to the naked eye had little appearance of being tubercular, nevertheless, the pus of all of them contained tubercle bacilli in small numbers.

TEST 3. The two calves of this experiment had previously been subjected to a similar comparative test with cultures of tubercle bacilli, the injection having been made in the trachea (July 17, 1898). The details of this experiment are described later.

In view of the apparently slight effects of the earlier inoculation it was thought that those lesions produced by the last inoculation in the peritoneum could at least with some probability be identified.

Of the first test it may be said here that according to the results of the tuberculin test the calf inoculated with the culture of bovine origin was diseased in consequence, whilst the other was not. Both were in fair condition and free from symptoms of disease.

Sputum II, from middle-aged negro in last stage of phthisis; died a few weeks later; no family history. Tubercle bacilli numerous, along with coccus and other forms.

December 28, 1898, calf L (Pen I), about one year old (had six months previously been injected in trachea with a culture of human tubercle bacilli, but failed later to react to tuberculin), received 2 C.C. of Sputum II (mixed with 5 C.C. of sterile water) in peritoneal cavity. A guinea pig inoculated with same died tuberculous in eight weeks.

Bovine Virus II—Piece of liver and attached lymph gland full of large tubercular masses, in some cases caseous, in others with small pus-containing cavities; a few recent tubercles are also present.

A particle of thick caseous material and two small yellow nodules were well broken up in water and the fluid part which contained tubercle bacilli sparsely distributed along with some putrefactive organisms was used for inoculation.

December 13, 1898, calf N (Pen II), about ten months old (injected in trachea six months previously with a culture of bovine tubercle bacilli and later reacted to tuberculin), received in the peritoneal cavity 7 C.C. of above. A guinea pig subcutaneously inoculated with a few drops of same died in three months with extensive generalized tuberculosis.

Both these calves were subsequently tested twice with tuberculin. In the first test, February 22, the result was positive for calf N, and doubtful for calf L. In the second, April 17, neither of them showed any reaction (Tables V, VI, pp. 80, 81).

The autopsy on these calves, made May 2 and 4, that is, five, and five and a half months after inoculation, is described further on (pp. 66, 67) under another experiment.

TEST 4. As a comparative test this is incomplete, the post-mortem examination of one calf being lacking.

Sputum IV, received at laboratory without history; tubercle bacilli, chiefly long granular forms, moderately numerous; other bacteria abundant.

February 15, 1899, calf T (Pen III), about two months old, received in peritoneal cavity 2 C.C. of above sputum in 5 C.C. sterile water.

A guinea pig (29) two-thirds grown, inoculated in subcuta with 0.2 C.C. of above dilution of sputum, and killed in a condition of emaciation three months later, showed translucent tubercles of lung, tuberculosis of liver, abscesses locally and in the inguinal and retroperitoneal lymph glands, and a number of small excrescences on the parietal peritoneum and diaphragm.

Bovine Virus IV. The specimens received consisted of pieces of liver and lung, containing caseous and calcareous nodules of all sizes, and two fist-sized lymph glands which are shells around a yellow mass of butter consistence. For inoculation a particle of the latter material was broken up in sterile water. This suspension contained tubercle bacilli rather numerously, short forms predominating, other organisms being apparently absent.

January 7, 1899, calf S (Pen IV), two months old, received 7 C.C. of above in peritoneal cavity.

A rabbit of full growth received in subcuta 0.2 C.C. of above suspension. It died in a state of emaciation in three weeks, but on dissection showed no gross tubercular nor other lesions to account for death.

The tuberculin test was applied to these calves on February 22 and April 20. In the first test neither animal reacted; in the second, calf T (sputum) gave a reaction which might be considered dubious; the other gave no reaction (Tables V, VI, pp. 80, 81).

The post-mortem examination on calf S, made on April 27, fifteen weeks after inoculation, showed an entire absence of any pathological changes, local or otherwise.

Calf T, which at the same date was apparently in the best of health and condition, was not killed but has been used for another experiment (with cultures).

Inoculation of sputum and bovine tubercle to pigs. The material used for these inoculations was that just described, namely, Sputum IV and Bovine Virus IV, diluted so as to make the content of tubercle bacilli in the two specimens approximately equal.

February 15, 1899, two pigs (Pen III), two to three months old, received each in the peritoneal cavity 1 C.C. sputum in 3 C.C. sterile water.

January 7 two pigs (Pen IV), three to four months old, received in the same way a similar inoculation with bovine tubercular material. These two pigs were rather larger than those used for the sputum inoculations.

On March 15, one of the pigs in Pen III (sputum inoculation) was found dead. It had refused food and was visibly pining for two weeks or more. The autopsy notes, somewhat condensed, are as follows: Seat of inoculation not recognizable; skin and subcutaneous lymph nodes normal; spleen shows some small superficial hemorrhages, not engorged; liver and kidneys to naked eye unchanged; right lung adherent to ribs and throughout in a state of suppurative inflammation. It is crowded on surface and in depth with minute abscesses most of them about the size of a pin head, a few slightly larger. The appearance at first glance recalls that of an excessive miliary tuberculosis with yellow nodules, but the contents of these nodules are fluid and purulent. A small area of the left lung is in a similar condition; slight reddening of the mucous membrane along the greater curvature of the stomach. At the pyloric and œsophageal openings are dark greenish, closely adherent, rough exudates. In small intestines is one small ulcer, probably due to ascarides, which are present in numbers. In the cæcum are many superficial ulcers of small size covered with a yellowish crust, easily removable. A few of these are also seen in the adjacent colon.

No lesions recognizable as tubercular were found in this animal, although it is possible that the miliary abscesses in the lung may have resulted from the inoculation (pyemic). The intestinal ulcers were doubtless those of hog cholera, a disease which was prevailing in the neighborhood, and with which the pig had probably been infected before its arrival. Tubercle bacilli were unsuccessfully sought for in the lung lesions. On the other hand, from the liver, an organism was obtained biologically similar to the hog cholera bacillus, although from pressure of other work its positive identity was not worked out.

The other pig in this pen, which seemed to have escaped this contagion, was killed May 18, three months after inoculation, and the post-mortem revealed the following changes: In the subcuta at the seat of inoculation is a small tuberculous and calcareous enlargement, and a short distance removed a lymph node in the same condition. In the peritoneal folds joining the large intestines, on the surface of the stomach, and in smaller number on the surface of the spleen and diaphragm, are numerous yellow nodules about the size of millet seed. A considerable number of yellow spots of about the same size but not projecting are seen on the surface of the liver. The substance of the liver and spleen are apparently normal. Two or three lymph glands of the colic omentum are tuberculous. Stomach and intestines throughout are unchanged. Bronchial glands not visibly altered. A group of lymph glands applied above to the manubrium sterni are enlarged and tuberculous, showing purulent pockets with calcification. There are some pleuritic adhesions and free fringes, some of which contain yellow nodules. These are most abundant on the thoracic surface of the diaphragm. The lungs at first sight seem to be normal, but on closer inspection are seen to be studded with minute points, best appreciated by the aid of a lens. They are also recognizable on the cut surface of the lungs, and give the impression of a very early stage of miliary tubercles, an opinion which was confirmed by the microscopic examination of sections.

The two pigs of Pen IV (inoculated with bovine tubercle) were killed April 27, about fifteen weeks after inoculation.

No. 1, a female, was free from local lesions. In the abdominal cavity the condition is similar to that described above but the gastric lymph glands are slightly tuberculous and the great omentum contains numerous pinhead-sized yellow nodules. There are no changes in the thoracic cavity.

In No 2 the tunica vaginalis of the spermatic cord is studded with yellow tubercles. Abdominal serosa and lymph glands as in No. 1, but the nodules are slightly larger and are present also on the surface of the spleen, liver and diaphragm. A few tuberculous lymph nodes in the colic omenta with slight calcification. Thoracic organs normal.

Tubercle bacilli in all these tuberculous lesions of the pig were found to be extremely rare, requiring much time and tedious work for their demonstration.

Experiments with cultures. The employment of artificial cultures in an investigation of this kind possesses some advantages as well as disadvantages, as compared with the natural disease products. The latter usually contain not only the specific bacilli but pyogenic and putrefactive organisms as well, which, in intra-peritoneal inoculations, may themselves induce pathologic changes or modify the action of the tubercle virus. In the case of bovine tubercular material, also, the content of the tubercle bacilli, as in two at least of the experiments just reported, may be too small to allow of a sufficient dose being obtained for inoculation of cattle. Any inherent racial distinction as regards the pathogenic activity of human and bovine tubercle bacilli are also best studied in pure cultures. On the other hand, by the use of the crude morbid products we approach more closely to the conditions of natural contagion.

It is evident that, as Th. Smith has well insisted upon in his experiments, a test of pathogenic activity of cultures of human and bovine origin can only be comparative when the modifying influence of artificial cultivation applies in equal degree to both, a requirement which in this instance is attended with a number of technical difficulties best appreciated by the bacteriologist.

The plan of my experiments includes comparative tests of cultures from the various samples of tubercular material already tested in the crude form in the foregoing experiments. So far, however, the complete records are available in the case of two cultures only, namely, those described as Sputum I and Bovine Virus I. Isolation in these cases was obtained by passage through the guinea pig. The culture medium employed in both cases was the blood serum of cattle to which had been added 6 per cent of glycerine, solidified by several hours heating at 80°-90° C., and afterwards sterilized by steaming in the usual way.* Ordinary test tubes were used, and drying of the media prevented by corking the mouth of the tubes, or covering them with tinfoil held closely in position by a rubber band.

Inoculation of cultures to calves. This experiment relates to four calves subjected to intra-tracheal and intra-abdominal inoculation. The history of the cultures may be briefly outlined thus:

Sputum I (See p. 50).
II-25,-'98—V-10-'98; growth in guinea pig 15.
V-10-'98; first transfer to tube from inguinal gland.
VI-26—; second transfer.
VII-7—; used for inoculation.
Bovine Virus I (See p. 51).
III-14-'98—V-16-'98; growth in guinea pig 16.

---

*Löffler's medium, pure serum solidified and sterilized as above, and serum with or without the addition of glycerine, sterilized according to the original Koch method, were also employed for comparison without, however, any very marked difference in the rapidity or size of the growth obtained. Some observations which I have made on the morphological and cultural characters of the bacilli of human and bovine origin I reserve for another communication.

V-16—; first transfer from lung tubercle.
VI-21—; second transfer.
VII-7—; used for inoculation.

Of the cultures used for inoculation that of the germ of human origin was the largest, but both were growing satisfactorily. For inoculation a piece about the size of a small pin head from each of the cultures was broken up in a few cubic centimeters sterile water and the fluid, which still contained small flakes, injected in the same manner as in the sputum injections, the dose being approximately alike for the two cultures. The inoculations were made July 7, 1898. The four calves employed in this experiment were from four to six months old and nearly of the same size. They had all been recently tested with tuberculin.

Calf L (Pen I) received 2 C.C. of suspension of Sputum Culture I in trachea; calf M (Pen I) the same amount in the peritoneal cavity.

Calves N and O (Pen II) received similar doses of the culture of bovine origin in the trachea and peritoneal cavity, respectively.

The outcome of the peritoneal inoculations may be described first: Calf O (inoculated with the bovine culture) began to pine in a few weeks and died on August 20, six weeks after inoculation. The following are the notes of the post-mortem examination:*

Died on the night of the 20th of August, and was examined on the 21st. Quite thin in flesh; some tumefaction at seat of inoculation due to tubercular masses; abdominal walls filled with tubercular deposits; omentum greatly thickened, completely filled with tubercular deposits, and closely adherent to abdominal walls, and in many places to intestines. Intestines covered with small tubercles. Under-surface of liver shows many small tubercular looking deposits; the spleen contains numerous tubercles as large as a split pea; the lungs are adherent to the chest walls and in places contain tubercular nodules on the surface.

---

*I was myself unavoidably absent at this time, and for these notes am indebted to the courtesy of a medical friend.

Some of the alcoholic specimens from this animal, examined later, were pieces of omentum and liver containing grape-like excrescences, and of lung in a condition of consolidation, on the surface of which small tubercles could be indistinctly seen. Altogether, the pathological findings in this case were similar to those of calf H (inoculated with Sputum I), only more extensive. There was, however, no evident calcification in those lesions examined. Tubercle bacilli were exceedingly abundant in sections of the excrescences on the omentum and liver, rare in sections from the lung.

Calf M (culture of human tubercle bacilli in the peritoneal cavity) did not seem to suffer in health from the inoculation. It was tested with tuberculin, October 27, giving a distinct reaction (Table III, p. 78), and killed for examination, December 1, about five months after inoculation.

Autopsy: The seat of inoculation is indistinguishable either in the subcutaneous tissue, or on the peritoneum. Several patches of a hand's breadth in size on the great omentum are beset with minute yellow seed-like calcareous granules and near to one of these patches is a flattened smooth polypoid growth about the size of a small bean. When incised this shows a tough fibrous structure with slight calcification in the center. Some of the mesenteric glands are pigmented to an unusual degree, and some three or four are found on section to contain small yellow calcareous particles in their cortical portion. No other lesions found.

Tubercle bacilli were found with some difficulty in the affected mesenteric glands. Microtome sections of the larger omentum growth were found to be necrotic and calcareous in the center and allowed of only an uncertain demonstration of tubercle bacilli. A guinea pig inoculated from the mesenteric glands obtained in due time a generalized tuberculosis.

Calves L and N which received the tracheal injection were also tested with tuberculin on October 27, the latter only responding to the test (Table III, p. 78). Both these animals being apparently but little affected, it was decided to use them again. They were accordingly injected on December 28 and 13, L with Sputum II, and N with Bovine Virus II, as already described (see pp. 56, 57). The autopsies on these animals only remain to be given.

May 4, calf L (culture human tubercle bacilli in trachea; Sputum II in peritoneum), was killed for examination.

Autopsy: On the left side of the trachea there is a slight thickening of one of the cartilaginous rings, the only mark indicating the place of the earliest inoculation. The abdominal cavity contains a few ounces of a yellow, odorless fluid. On the abdominal surface of the diaphragm, and on the surface of the spleen, are numerous small loosely-attached growths, white, pink, or reddish in color, and seldom exceeding a pin head in size. They appear to be of a hard fibrous structure, without calcification. On the surface of the liver, besides a few of these growths, are a number of small yellow, nonprojecting spots. The diaphragm also contains a few thin, loosely attached fringes. The intestinal walls contain a number of nodules of parasitic origin. All lymph glands and other abdominal viscera normal. Bronchial and mediastinal glands normal. The surface of the lungs show a number of bluish, semi-translucent, globular bodies scarcely larger than a millet seed. Some of these could also be seen on the cut surface. They are nowhere very numerous and to the naked eye do not resemble tubercles. Near one apex is a patch of consolidation about one inch in diameter which appears to be of parasitic origin. There are a few slight pleuritic adhesions, and a considerable number of thin, pale, or reddish fringes attached to the pleura costalis.

Tubercle bacilli were not found in any of the lesions of this calf. The small nodular bodies found in the lung were histologically of highly vascular lymphoid structure without any features to show that they were of tubercular origin. As for the other insignificant thoracic lesions—pleuritic adhesions and fringe formation—their origin may, with equal probability, be ascribed to either the tracheal or the abdominal inoculation.

May 2, calf N (bovine culture in trachea; Bovine Virus II in peritoneum), killed for examination, revealed the following lesions: General condition fair. In neck at place of inoculation are five or six thick-walled abscesses, the largest about the size of a walnut, extending from the subcuta inward beneath the muscles to the trachea. On the inner surface of the trachea, where the inoculating needle had penetrated, are three fleshy looking flat growths from three-quarters of an inch to two inches in length, about half that breadth and a quarter of an inch in thickness. They are rough and apparently ulcerating on the surface. A number of large tuberculous and calcareous lymph nodes are found beneath the trachea, posterior to the place of inoculation. The bronchial glands, lungs, and pleura are normal.

These purely local lesions are all that can be ascribed to the tracheal inoculation.

On the folds of peritoneum connecting the divisions of the large intestine, on the abdominal surface of the diaphragm, and on the capsule of the spleen are a number of flat, loosely attached, fibrous looking growths of a pink color, and none exceeding the size of a small bean; a few are also present on the great omentum. No tubercles are visible in these growths, and no calcification detected on incision. None of the abdominal lymph glands are evidently tuberculous; liver shows a few white spots on surface; the parietal peritoneum is clear, and no trace remains of the place of inoculation. The walls of the ileum contain a few helminth nodules.

The abdominal lesions in this calf differ from those of the preceding, only in the larger size of the new formations on the serosa.

A scraping from the ulcerating surface of the tracheal growths showed a few tubercle bacilli, both long and short forms being present.

The features of this test which call especially for notice, are the failure of reaction to tuberculin at the last test, and the long continuance of local effects in the trachea without involvement of the lungs or bronchial glands.

Inoculation of cultures to chickens. The cultures were of the same series as used in the last described experiments.

June 16, 1898, five three months old chicks each received one-half cubic centimeter of a strong suspension of Sputum Culture I in the peritoneal cavity, and five others were similarly treated with the bovine culture. One chick untreated was added to each pen.

One of the sputum lot died on October 24; the others were killed and dissected November 8. All were very thin, but quite free from tubercular disease or any other gross anatomical changes.

Other experiments with the same cultures were made later. On account of my absence the regular monthly transference of these cultures was interrupted for a period of four months, the tubes during this time being kept in the incubator without artificial heat. When transfers to fresh tubes were again made it was found that the cultures of human source which previously had shown the most vigorous growth now grew very feebly and in fact after two more transfers refused to grow at all. This was the case with all the tubes (over a dozen) which had been kept. The bovine cultures under exactly the same conditions showed no impairment of vegetative activity. It would be interesting to know whether or not this difference in longevity in artificial cultures is a constant distinguishing feature between the two varieties. I have, however, at present no further data to offer. Although the diminished vegetative power of these cultures was recognized, it was not known that their vitality was seriously impaired until after the experiments now to be described were already under way. These experiments, for the reason given, lose much if not all of their value as comparative tests, but have a certain value as illustrating the action of the bovine culture.

A mixture of the third and fourth transfers of the above series No. I, human and bovine, was used in each case, the third transfer being four to six months old, the fourth from three to six weeks. The sputum culture, although of enfeebled vegetative power on artificial media, still retained in part at least its pathogenic activity. A guinea pig of nearly full growth subcutaneously inoculated with 0.2 C.C. of the suspension used on calf K, died in three months with extensive tuberculosis in both abdominal and thoracic organs and allowed of a resuscitation of the culture, good growths being obtained from the lung, spleen and inguinal gland. The death of this culture on artificial media was, therefore, not preceded by attenuation of virulence. The result was different, however, with rabbits, as the following experiment shows: Two rabbits, nearly full grown, received, December 7, 1898, in the peritoneal cavity 0.3 C.C. of a suspension in normal salt solution of the human and bovine cultures. That receiving the bovine culture died April 4 (about four months after inoculation), after a long period of ill health with dyspnœa and purulent discharge from the eyes and nostrils. Dissection revealed extensive tubercular disease: A solid tumor the size of a peanut is found in the subcuta at the place of inoculation. All through the abdominal cavity are small yellow nodules; on large intestine a bean-sized, fleshy excrescence; omentum thickened and containing many large and small nodules; lymph nodes caseous; spleen apparently unaffected; liver has a few yellow points on the surface only; yellow patches, apparently tubercular changes, are present on the surface of the kidneys. The diaphragm on its abdominal surface shows a number of tubercular excrescences. Both lungs are crammed full of yellow tubercles, rendering them practically solid and incollapsible.

Tubercle bacilli (short-solidly staining forms) are very abundant in the lung tubercles, rare in the other lesions. Calcification was not observed anywhere.

The other rabbit was killed, in excellent condition, April 27. The findings in this case consisted of small yellow tubercles on the serous covering of the spermatic cord of both sides (the inoculations were made in the hypogastric region); a small excrescence on the peritoneum at the place of inoculation, and a few whitish spots on the surface of the liver.

Tubercle bacilli, mostly long, curved, and granular, but also short and homogeneous, were demonstrated in the tubercles of the vaginalis.

Inoculations of cultures in the lungs of calves. December 7, 1898, two calves, K and I, each ten months old, and previously tested with tuberculin, received 7 C.C. of a suspension of sputum and bovine cultures, respectively, in the right lung.

The tuberculin test, applied February 22 and April 17, yielded a reaction both times in calf I; in calf K a doubtful result the first time and a negative result the second (Tables V, VI, pp. 80, 81).

Calf I (inoculated with bovine culture) was killed May 9, five months after inoculation, in rather poor flesh, but without outward evidence of disease. *Autopsy:* Right prescapular lymph node enlarged and tuberculous; a few small yellowish patches on surface of liver and in its substance; numerous small helminth nodules in walls of small intestine; no other abdominal lesions. Right lung at place of inoculation contains an abscess the size of a hen's egg, with small tubercles on the surface around, the whole being consolidated to the extent of two hand breadths. There is a dry pleuritis with a few adhesions on the right side; right costal pleura through most of its extent studded with small yellow tubercles, pea-sized pedunculated bodies, and leaf-like or fringe-like outgrowths. The latter are present also on the lung surface, on the diaphragm, and, in small number, on the costal pleura of the left side. Some of these show a thickening at their free end, with or without the presence of small tubercles. In consistence they are hard, fibrous, and the larger of them calcareous in the center. Bronchial glands tuberculous and calcareous.

In the contents of the lung cavity tubercle bacilli are present, not very abundantly.

Calf K, which at this time appeared in excellent condition and had failed to react to tuberculin, was not killed but has been reinoculated with another vigorously growing culture.

Feeding cultures to calves. Two calves, each three months old, were fed on four occasions during January, 1899, with particles of culture broken up in water and mixed with milk, a small pinhead-sized piece of the cultures being used each time.

February 22, and again April 18, the calf (R), receiving the bovine culture, responded to the tuberculin test, whilst the other (Q) did not (Tables V, VI, pp. 80, 81). The former was killed, April 31, four months after the beginning of the experiment and the dissection revealed only slight tubercular changes in the mesenteric glands and liver. Only a few of the mesenteric glands were involved. The liver was studded over most of its surface with small yellow spots. The apex of one lung was consolidated and close by was a pea-sized pus-containing cavity, but these lesions were probably not tubercular. They contained small oval bacteria in large number but no tubercle bacilli could be found. The bronchial glands were normal.

The other calf has not been killed as there was little probability of its being infected.

Feeding and inoculation of pigs with cultures. Six pigs, about three months old, were employed in this experiment. Three of these were fed with sputum culture and three in another pen with bovine culture exactly as in the experiment last described with calves, one pig in each lot receiving in addition an intra-peritoneal inoculation. All were killed and examined four months later with the following results: The pigs receiving the sputum culture were entirely free from disease. Of the other lot all were infected.

Pig No. 1 (fed and inoculated) shows enlargement and caseation of the inguinal glands of both sides; at the place of inoculation an irregular, lumpy, tuberculous mass the size of a hen's egg; tubercular growths along the vas deferens of both sides; both testicles tuberculous; omentum a mass of yellow nodules the size of a pea; larger nodules and outgrowths in great numbers on the colic omenta; many excrescences on the walls of the stomach and bowels and on the parietal peritoneum; both surfaces of diaphragm crammed with tubercles; nodules reaching to the size of a pea on the surface of the spleen and liver, and a few smaller ones in the substance of these organs; abdominal lymph glands generally large and tuberculous; kidneys not visibly altered; lungs spongy but full of minute translucent tubercles. In the pleura are some slight adhesions and many white flattened excrescences from the size of a bean downwards; bronchial glands large and caseous.

Pig No. 2. Parotid and submaxillary glands tuberculous, the latter on one side converted into an abscess as large as a hen's egg; a large patch on the surface of stomach covered by small yellow granulations; mesenteric and gastric lymph glands tuberculous; miliary tubercles on both surfaces of diaphragm; parietal peritoneum generally clear.

On the mucous surface of the colon are a number of small nodules the tubercular nature of which is uncertain; on surface of liver a small number of yellow spots; bronchial glands tubercular, and lungs full of minute translucent tubercles.

In pig No. 3 tubercular disease was present only in the submaxillary and mesenteric glands.

Tubercle bacilli were found to be rather scarce and difficult of demonstration in all these lesions of the pig. Calcification was not a prominent feature, being, indeed, only recognizable in the microtome sections. The lesions of the liver, in the form of yellowish white, superficial spots, were found to be tubercular on microscopic examination. They were gritty on section and histologically showed a central necrotic area surrounded by a mass of small round nucleated cells with which are intermixed many elongated or spindle-shaped cells. Tubercle bacilli were found in small number.

Inoculation of cultures to sheep. The inoculations (intra-peritoneal) were made December 16, 1898, in the hypogastric region, to the right of the median line, with the same material as in the previous experiments. Two sheep of nine months were employed and kept in separate pens.

The animal inoculated with the bovine culture died April 18 (four months after inoculation), after a long period of unthrift. It was found to be extensively diseased. The submaxillary glands of the right side contain small calcareous tubercles; large, irregular, calcareous tuberculous masses in the subcuta at the seat of inoculation; great omentum over half an inch thick and crammed with yellow, calcareous tubercles; numerous flat pedunculated excrescences from the size of a small bean downwards and all calcareous are scattered over the whole abdominal serosa, including that covering the liver and spleen. The substance of these organs appears as if disintegrated. The spleen pulp is soft and reddish yellow in color and contains many seed-like calcareous particles. The lungs scarcely collapse when the thorax is opened; they are almost solid from the presence of yellow tubercles crowded together on surface and in depth.

In sections, tubercle bacilli, both long and short forms, are readily found, though not very numerous, in the lung tubercles.

The other sheep was killed, evidently in good health and condition, April 21. The only lesions found referable to the inoculation were a number of nodules the size of millet seed scattered over the omentum opposite the place of inoculation. Helminth nodules were moderately numerous in the walls of the intestine and a few were also found in other unusual situations. In the walls of the stomach were about a half a dozen, two on the surface and one in the depth of the liver, and one on the omentum. These nodules bear a superficial resemblance to tubercular lesions but are distinguished by their greenish contents, by the absence of tubercle bacilli, and the presence in some of them of the minute parasite (Oesophagostoma Columbianum, Curtice) which occasions them.

TABLE I.

Tuberculin Test.* Injections Made May 13, 1898, at 8 p. m. Tuberculin Solution (Pasteur Vaccine Co.) in Doses as tabulated.

	E		F		G			H		
Date.	13th	14th	13th	14th	13th	14th	15th	13th	14th	15th
8 a. m.	102.4	103.5	101.8	103.1	102.8	102.9	102.8	103.0	105.1	103.8
9:30 a. m.	....	104.5	....	103.4	....	102.7	....	....	105.1	....
11 a. m.	102.3	106.0	102.3	103.2	103.2	103.0	102.8	102.8	105.1	103.7
12:30 p. m.	....	105.5	....	102.8	....	....	....	....	104.8	....
2 p. m.	102.4	....	102.2	103.0	102.9	102.8	102.5	103.0	....	103.7
3:30 p. m.	....	104.5	....	....	....	103.0	....	....	105.4	....
5 p. m.	....	104.0	....	102.9	....	103.5	102.3	....	105.6	103.4
8 p. m.	103.1	....	103.2	....	103.3	103.6	....	103.2	105.6	....
10 p. m.	....	....	....	....	....	104.1	....	....	104.8	....
	1.5 cc		0.75 cc		1.25 cc			0.75 cc		

Remarks: E. Tracheal injection of sputum. Reaction.
F. Peritoneal injection of sputum. No reaction.
G. Tracheal injection of bovine tubercle. No reaction.
H. Peritoneal injection of bovine tubercle. Reaction.

---

*This method of tabulating the results of tuberculin tests, which was recommended by me a number of years ago, possesses the advantage over others, that the temperature readings at corresponding periods of two or more days are shown on the same line and can be readily compared. Although the variation during the twenty-four hours is not very regular, it is the rule that the body temperature in cattle is higher in the evening than in the earlier part of the day. What is wanted in these tuberculin tests is to find the increase of temperature due to the injection alone, and this is not obtained by taking as a standard the temperature at the time of injection or even the average temperature of the preceding day, but by comparing the temperature at the same hour on the day preceding and following the injection. It is with the view of illustrating these points as much as of completing the records of the experiments detailed in the preceding pages that I have thought it worth while to publish these temperature readings.

TABLE II.

Tuberculin Test. Injections Made June 24, 1898, at 8 p. m.

	E		F		G		H		I		K		L		M		N		O	
Date.	24th	25th	24th	25th	24th	25th	24th	25th	24th	25th	24th	25th	24th	25th	24th	25th	24th	25th	24th	25th
8 a. m.	101.6	102.2	104.5	103.3	102.8	102.8	102.9	103.9	102.8	102.7	102.6	103.4	102.8	102.8	102.8	102.2	102.8	103.3	102.8	102.2
11 a. m.	101.6	102.0	104.2	103.8	102.7	102.8	103.0	103.9	102.8	103.1	102 4	103.0	103.1	102.2	103.3	103.2	103.2	103.4	102.8	102.9
2 p. m.	102.2	102.5	104.1	103.5	102.9	102.8	103.0	103.9	103.8	103.5	102.6	102.9	103.4	102.5	103.6	103.5	103.6	103.0	103.1	102.9
5 p. m.	102.0	....	104.2	....	103.7	....	103.2	103.3	104.2	....	103.9	....	103.2	....	104.0	....	103.8	....	103.5	....
8 p. m.	102.8	....	104.8	....	103.8	....	104.0	....	103.5	....	103.5	....	104.0	....	104.0	....	104.3	....	104.2	....
	2 CC		1 CC		1.5 CC		1 CC		0.75 CC		0.75 CC		1 CC		0.5 CC		0.75 CC		0.75 CC	

Remarks: E, F, G, H, second test (see table I); no distinct reactions.
I, K, L, M, N, O, (untreated), preliminary test—no reactions.
The table shows the variable and often comparatively high temperature of young cattle, the usually higher temperature in the evening than in the morning, and on that account the advantages of this method of tabulating thermometric readings.
The temperature of calf F is probably pathological.

TABLE III.

Tuberculin Test. Injections Made October 27, 1898, at 8 p. m.

	L				M				N			
Date.	26th	27th	28th	29th	26th	27th	28th	29th	26th	27th	28th	29th
8 a. m.	100.8	101.5	102.5	101.8	99.9	101.0	102.2	101.8	101.3	100.5	103.9	102.7
10 a. m.	....	....	100.9	....	....	....	102.1	....	....	....	102.9	....
12 a. m.	101.7	....	101.8	101.5	102.4	....	104.0	102.7	101.0	....	103.2	102.8
2 p. m.	....	102.6	102.5	....	....	102.4	105.0	....	....	102.0	104.7	....
4 p. m.	102.8	....	103.1	102.5	103.2	....	105.3	103.5	103.1	....	105.2	103.3
6 p. m.	....	....	103.0	....	....	....	....	....	....	....	....	....
8 p. m.	....	102.5	....	....	....	103.1	103.7	....	....	103.4	103.6	....
	1.5 cc				1 cc				1.5 cc			

Remarks: L. Sputum culture in trachea; no reaction.
M. Sputum culture in peritoneum; reaction.
N. Bovine culture in trachea; reaction.

TABLE IV.

Tuberculin Test. Injections Made November 3, 1898. at 8 p. m.

	E		G		I		K	
Date.	3d	4th	3d	4th	3d	4th	3d	4th
8 a. m.	102.2	102.0	102.7	102.4	102.0	101.5	102.2	102.3
10 a. m.		101.8		102.3		102.1		102.0
12 m.	101.8	101.8	102.4	102.4	102.7	102.2	102.2	102.5
2 p. m.		102.1		102.4		103.2		102.1
4 p. m.	102.4	102.7	102.8	102.8	103.1	103.2	102.8	102.5
8 p. m.	102.2		103.4		102.7		102.6	
	2.5 cc		2.5 cc		1.5 cc		1.5 cc	

Remarks: E, G, third test (see Table I); no reaction.
I, K, (untreated) preliminary test (second).

TABLE V.

Tuberculin Test. Injections Made February 22, 1899, at 8 p. m.

	E		G		K		I		L		N		Q		R		T		S	
Date.	22d	23d	22d	23d	22d	23d	22d	23d	22d	23d	22d	23d	22d	23d	22d	23d	22d	23d	22d	23d
8 a. m.	101.7	101.8	101.3	102.4	102.6	103.2	102.4	105.4	101.6	104.6	100.5	104.5	101.7	101.0	101.6	104.0	101.5	101.8	100.5	100.6
10 a. m.	....	101.3	....	102.6	....	102.5	....	105.3	....	103.0	....	105.0	....	101.2	....	104.3	....	102.2	....	100.5
12 m.	101.0	101.1	101.3	102.7	101.7	103.6	103.7	105.1	101.6	102.2	101.7	104.9	101.8	102.3	102.5	105.7	102.2	102.2	99.7	100.8
2 p. m.	....	102.1	....	103.5	....	103.1	....	105.3	....	102.3	....	....	....	102.7	....	105.8	....	102.5	....	....
4 p. m.	102.0	102.7	102.6	102.8	102.2	102.2	104.3	104.4	102.0	102.3	102.2	104.9	....	103.2	....	105.7	102.7	....	101.1	101.6
8 p. m.	102.1	....	102.2	....	102.4	....	103.0	....	102.5	....	102.5	....	102.0	....	102.5	....	102.5	....	102.0	....
	2.5 cc		2.5 cc		1.5 cc		1.5 cc		1.75 cc		2 cc		0.75 cc		0.75 cc		0.75 cc		0.75 cc	

Remarks: E, G, fourth test (see Table I); no reaction.
K. Sputum culture in lung; no reaction.
I. Bovine culture in lung; reaction.
L. Sputum in peritoneum (see also Table III); doubtful reaction.
N. Bovine tubercle in peritoneum (see also Table III); reaction.
Q. Fed sputum culture; no reaction.
R. Fed bovine culture; reaction.
T. Sputum in peritoneal cavity; no reaction.
S, Bovine tubercle in peritoneal cavity; no reaction.

TABLE VI.

Tuberculin Test. Injections Made April 17, 1899, at 8 p. m.

	E		G		K		I		L		N		Q		R		T		S	
Date.	17th	18th	17th	18th	17th	18th	17th	18th	17th	18th	17th	18th	17th	18th	17th	18th	17th	18th	17th	18th
8 a. m.	101.7	103.5	101.7	103.5	101.5	102.5	101.9	104.7	100.0	101.7	101.6	102.7	102.0	102.1	101.8	103.2	101.8	102.8	101.2	101.8
10 a. m.	....	102.6	....	102.7	....	102.7	....	104.7	....	101.2	....	102.8	....	102.1	....	103.2	....	103.3	....	102.0
12 m.	101.0	101.9	102.1	102.9	101.6	102.5	101.6	103.5	100.9	101.4	101.7	102 4	101.7	102.5	102.3	103.5	102.6	103.7	102.1	102.5
2 p. m.	....	102.0	....	102.6	....	102.7	....	104.6	....	101.8	....	102.2	....	102.4	....	104.2	....	103.4	....	102.0
4 p. m.	102.0	....	102.8	....	102.4	....	102.8	103.8	101.8	....	102.3	....	102.7	....	103.7	105.4	102.6	103.0	102.6	....
8 p. m.	102.8	....	103.0	....	....	....	....	....	103.0	....	103.3	....	102.0	....	102.2	....	....	....	....	....
	2.5 CC		3 CC		2 CC		1.75 CC		2.5 CC		2 CC		1 CC		1 CC		1 CC		1 CC	

Remarks: (For references to animals by letter, see preceding table). In this test there is one doubtful reaction (G), two positive (I and R), all the others negative, the latter list including one calf (N) which reacted in the preceding test.

In presenting in a condensed form the results of the foregoing experiments, each animal species may be most suitably considered separately.

CATTLE: *Feeding tests with tubercular sputa of man.* Of four calves subjected to this test all failed to give a tuberculin reaction, and, according to the post-mortem examination, all remained absolutely uninfected. (This test is not comparative, as no similar experiments with bovine tubercle were undertaken.)

Inoculation of sputum and bovine tubercular material. Intra-tracheal inoculation was tested on two calves. The sputum injected calf alone responded to the tuberculin test. The changes found on post-mortem were in both cases slight roughened patches on the pleura without visible evidence of any tubercular process; in the sputum test no local lesion, in the other a number of abscesses in which tubercle bacilli were found.

Intra-peritoneal inoculation. Four calves in each series. Of the sputum series, two gave doubtful and two negative reactions to tuberculin; of the bovine series, two positive and two negative. The pathological changes in the sputum lot were: In one, no lesions; in another a few roughened patches and seed-like granules on the omentum with slight fringe formation on various parts of the abdominal serosa; a few whitish spots on surface of liver. The fourth was not examined post-mortem.

The bovine series showed: In one, no lesions; in two, changes similar to the above but somewhat more extensive; in the fourth a very extensive development of grape-like growths containing tubercles all over the peritoneum, a few of same on thoracic surface of diaphragm, tuberculosis of some of the abdominal lymph glands.

Comparative tests with sputum and bovine cultures. Intra-tracheal inoculation on two calves. The sputum-tested animal gave no reaction to tuberculin. The post-mortem findings were slight pleuritic adhesions, fringe development on costal pleura, a few lymphoid nodules the size of millet seed histologically showing no relation to tubercles in lungs. Bovine culture: Locally a number of abscesses external to trachea and fungus-like ulcerating growths on its mucous surface, all containing tubercle bacilli, lower cervical lymph nodes tubercular.

Intra-peritoneal inoculation. Two calves. Sputum culture: Reaction to tuberculin. On omentum are several patches studded with millet-seed-like calcareous granules, and one small bean-size polypoid growth; a few mesenteric glands tubercular. Bovine culture: Fatal result in six weeks. Acute tubercular disease involving all the abdominal and thoracic organs; lesions in the form of miliary tubercles, large yellow nodules and fibrous grape-like growths on serous surfaces; tubercle bacilli very abundant.

Inoculation in lung. Two calves. Sputum culture: No tuberculin reaction; no post-mortem. Bovine culture: Tuberculin reaction; abscess with surrounding consolidation and tubercles in lung; numerous tubercles in pleura; fringe formation; tuberculous bronchial glands.

Feeding. Two calves. Sputum culture: No reaction to tuberculin; no post-mortem. Bovine culture: Reaction to tuberculin; mesenteric glands tubercular; many yellow spots on liver.

PIGS: *Feeding sputa* to six pigs resulted in infection in two, the disease being confined to the submaxillary and mesenteric glands.

Intra-peritoneal inoculation of sputa and bovine tubercular material. Four pigs. Sputum lot: One died from other disease before effects could be produced. The other shows a local lesion, a general tuberculosis of abdominal serosa, tuberculous abdominal and thoracic lymph glands, and embolic tubercles in lungs. Bovine lot: Both presented essentially the same condition as the last described, in the abdominal cavity, but no extension to thorax.

Intra-peritoneal inoculation of cultures. Two pigs. Sputum culture: No lesions. Bovine culture: In one generalized; in the other localized in submaxillary and mesenteric glands.

SHEEP: *Intra-abdominal inoculation of cultures.* Two sheep. Sputum culture: Patch of seed-like granules on omentum. Bovine culture: Generalized disease ending fatally.

CHICKENS: *Feeding sputa.* Six chickens. All unaffected.

Intra-abdominal inoculation of sputum and bovine cultures. Ten chickens. Both lots were unaffected.

We may now attempt an analysis of these results in order to see what conclusions they lead to and to what extent they harmonize with the results of the previous investigations of the same kind brought together in the first part of this report.

In the case of cattle a striking feature of these experiments is the insignificance of the lesions induced by the various inoculations of both human and bovine crude tubercular material. With one exception these were so slight as hardly to afford sufficient basis for instituting a comparison of the pathological-anatomical changes in the two series. With sputum or with cultures from sputum no disease was obtained equal in extent to anything except the mildest form of natural infection. Feeding was entirely ineffective. Inoculation gave rise to slight lesions on surfaces reached by the injection fluid—local lesions. These, however, were specific so far as they went. The tubercles, minute, and calcareous, and the peculiar fibroid new formations, also minute, on the abdominal serous surfaces, are not effects such as might result from the injection of any irritant fluid. The former may, indeed, be compared to the effects of dead tubercle bacilli such as have been observed by several writers (Prudden and Hodenpyle; Stockham), but the latter, as well as the fringe formations with which they are associated, I regard as the incipient stage of the peculiar form of tuberculosis of cattle, the so-called "Grape disease." Support for this view is found in the occurrence of transitional forms between the minute growths, apparently purely fibrous and destitute of tubercles, and the large grape-like tubercle-containing masses of the natural disease. These, in the form of pea-sized polypoid growths, were found in calves inoculated with sputum as well as with bovine material. Further, all of these growths except the most minute have a calcareous necrotic center; histologically they do not markedly differ from the larger masses, and if sufficient time be spent on the search, a demonstration of tubercle bacilli can generally be made.

We may, therefore, look upon these lesions found in the sputum infected cattle as representing an interrupted or abortive development of grape disease. To what is this abortive or nonprogressive character of the disease to be attributed? Manifestly not entirely to a difference in kind of pathogenic action between the human and bovine virus since two of the calves inoculated with the latter presented lesions differing not in kind but only slightly in degree or extent from the above. It should be ascribed rather to the inherent disease-resisting power of the animal organism, fortified in the case of these experimental animals by the absence of all confinement in stables, for, in my opinion, defective ventilation is scarcely less important than contagion as a factor influencing the prevalence of tubercular disease in man and in animals.* It should be remembered, too, that the naturally acquired disease in cattle is very rarely acute, and when the conditions are favorable, seldom even progressive. Tuberculosis in cattle is really a disease incident to domestication and dependent especially upon the pernicious influence of confinement in stables, for an adequate ventilation of any covered building in which a number of cattle are confined I regard as a practical impossibility.

Comparing the virulence for cattle of the samples of human and bovine tubercular material used in these inoculations we may say that the bovine material showed itself of varying activity, but on the whole more virulent than human sputa. In one sample this excess of virulence was marked, in the others only slight. This excess of virulence was brought out more prominently in cultures in the one comparative test made.

Pigs. These animals are susceptible to infection with both human and bovine tubercle. For reasons already given but one sample of each has been tested in such a way as to make the comparison a just one, and, judging from this test, bovine tubercle is no more active for these animals than human sputum. The kind of pathological changes induced in the two cases are identical. The liability to generalization of the disease in pigs, a feature which has been noticed by other observers, is noticeable also in these inoculation experiments.

Sheep are evidently highly susceptible to bovine tubercle bacilli. My one experiment on this species is insufficient to justify a positive verdict as to their susceptibility to human tubercle bacilli.

---

*The influence of repeated injections of tuberculin in modifying the course of tuberculosis in cattle is entirely conjectural and based, so far, on no evidence of scientific value.

Chickens showed themselves equally refractory to both. The inoculation of relatively large doses of recently isolated and vigorously growing cultures never occasioned even local lesions.

General Review. The facts presented in the foregoing pages admit of profitable study and analysis from more than one point of view, but it is sufficient to consider them here only in so far as they constitute evidence on the subject of this inquiry, namely, the relative pathogenic activity of human and bovine tubercle for the various species of domesticated animals. Although some few facts are available in regard to most of these species it is only in the case of cattle that this evidence is at all extensive. In other animal species (with the exception of guinea pigs and rabbits) it is so meager as to be hardly more than suggestive. It is, however, in the case of cattle that the question possesses its greatest practical importance and, therefore, demands the most consideration.

We may present the matter to be determined (as far as the evidence will allow) in the form of three questions:

1. Is tubercular disease communicable from man to cattle?

2. If so, is the disease thus induced similar in kind to the naturally acquired tuberculosis of cattle?

3. Other things being equal, is the susceptibility of cattle equally great for the human and bovine tubercular virus?

The first question can hardly be said to be in dispute, nearly all experimenters who have inoculated human tubercle or cultures to cattle having obtained at least a local development of tubercular lesions.

As to the second question—the identity in nature of the lesions induced by infection of cattle with human and bovine tubercle—the evidence furnished by the experiments of such pathologists as Klebs, Kitt, Bollinger, Baumgarten and Crookshank, not to speak of others of less note as histologists, seems to be irrefutable in establishing the fact that the lesions peculiar to cattle tuberculosis in its most typical form, the fibro-tubercular masses of "grape disease," are attributable to a peculiarity in the mode of reaction of the organization of cattle against the tubercular virus rather than to any peculiarity inherent in the bovine tubercle bacilli as distinguished from the human variety. My own experiments, both with calves and pigs, seem to afford confirmatory evidence of the correctness of this view.

The question of the relative susceptibility of cattle to human and bovine tubercle is not one of recent origin since it is involved in the question as to the identity of tuberculosis in man and cattle, which was one of the first objects of inquiry by those who sought to establish the contagious nature of this disease.

The etiological identity of the disease in man and cattle, first suggested by the similarity of the lesions and then more forcibly by the results of inoculation of rabbits and guinea pigs, received first its apparently complete confirmation by the experiments of Chauveau. His experiments afford evidence not only of the identity of the disease in the two species but of a susceptibility of cattle to human tubercle equally as great as to the bovine virus. They have one disadvantage, however, in the fact that they stand alone. No other investigator, so far as I can find, has ever obtained even a distinct infection of cattle by feeding human tubercular material, although the experiment has been repeated a number of times. The reputation of Chauveau as an investigator is, however, a guarantee of the accuracy of these experiments, and the difference in the results of his experiments and those of others who have made the same test may be due to conditions of environment, or even to an unsuspected extraneous infection of his cattle.

With this exception, all comparative tests which have been made show a greater susceptibility of cattle for the tubercular virus of bovine than of human origin. A study of the results of those experiments, much more numerous, which were not comparative leads to the same conclusion. A certain degree of susceptibility of cattle towards human tubercle is clearly shown by many inoculation experiments, especially intra-peritoneal, but the infection experiments with bovine tubercle have been more generally successful and led to more extensive disease. Pütz seems to have been the first to demonstrate this difference in virulence and attaches to it, as we have seen, more importance than will be generally conceded. Smith has shown that this difference is even more clearly brought out by the use of cultures, and, finally, my own experiments both with the natural disease products and (more strikingly) with cultures, admit of a similar interpretation. It seems, therefore, that it may be laid down as a rule that cattle are more susceptible to the tubercular virus of their own kind than to that of man, as represented by the excretions of pulmonary tuberculosis and cultures from the same. To this rule further investigation may show that there are exceptions. Just as there are apparently races of tubercle bacilli of man possessing different degrees of pathogenic power so there may be races of unequal activity in cattle. The samples of bovine tubercle tested in my experiments, for instance, seem to vary in virulence for cattle, although these experiments were not of such a kind as to best bring out racial distinctions. It should also be noted that the human tubercle virus tested on cattle, at least in the more recent experiments—those of Frothingham, Smith, and myself—has been that of only one form of human tubercular disease, namely, pulmonary phthisis.*

On the other species of domesticated animals, although comparative tests are few, various feeding and inoculation experiments have been made from which some information may be gleaned.

Horses are susceptible to inoculation with human tubercle (Pütz). Several cases are reported in which infection seemed with great probability to be derived from cattle. Nothing can be said as to any difference in susceptibility.

Sheep, as we have seen, are susceptible to inoculation with bovine tubercle to a degree apparently equal to that of cattle themselves, although the naturally acquired disease in this species seems to be extremely rare. Besides my own experiment a number of successful inoculation and feeding tests are reported in the preceding pages. Attempts to infect sheep with human tubercle seem to have been generally unsuccessful. I have only found one exception (Blumberg, p. 11), and the record in this case is of the briefest.

Goats seem to have a susceptibility similar to that of sheep (Gerlach, Bollinger, Kitt, Semmer).

Swine are readily infected with bovine tubercle. This has been frequently shown experimentally (Gerlach, Bollinger, Toussaint) and still more frequently by observation of natural infection from the use of milk of diseased cows. Few tests seem to have been made on these animals with human tubercle. Two instances of infection are, however, recorded (Blumberg, Bollinger) besides my own. So far as the evidence goes they seem to show no difference in susceptibility towards human and bovine tubercle.

---

*Both Klebs's and Kitt's intra-peritoneal inoculations seem to have been made with material derived from scrofulous glands.

I have at present under weigh some experiments with scrofulous material which I hope to report on later.

Dogs and *cats* also show a susceptibility to the virus of both sources. With bovine tubercle successful experiments are reported by several writers (Scholtz, Viseur, Semmer, Toussaint) and with human tubercle by one (Bollinger). There are, however, numerous observations of fatal infection of these animals by ingestion of human sputa.

Poultry, as is well known, are highly resistant to infection with mammalian tuberculosis. However, Nocard and others have observed instances of what appeared to be natural transmission from feeding on human tubercular sputa. Nocard's recent successful transference of mammalian tuberculosis to poultry were made with material of human origin.*

In my experiments, infection was not obtained with cultures of either source. That they are not readily infected by contagion from cattle is also shown by the absence of all observations of this kind in spite of the unlimited opportunities for contagion afforded by the manner in which poultry are raised, in this country at least, in association with cattle in stable and yards.

Rabbits have been found by many observers, even back to the time of Villemin's early inoculations, to be more susceptible to cattle than to human tuberculosis. In *guinea pigs* this distinction is less recognizable on account of their extreme susceptibility to both forms. Klein and Gibbes (p. 14) concluded from their experiments that these animals were most susceptible to the human virus, but this observation finds no support from other investigators.

To sum the matter up in a few words it may be said that bovine tubercle has been shown more virulent than the human variety for cattle, sheep, goats, and rabbits, while no distinction has been shown in the case of horses, pigs, cats and dogs.

---

*Annales de l' Institut Pasteur, 1898, page 561.

Before leaving the subject some allusion should perhaps be made to its practical aspects.

In animals other than cattle, tuberculosis is of such rare occurrence that the source from which they receive the contagion is a matter of minor importance. In all animal species we must concede the possibility of a transmission from one individual to another in the same herd, but it is only in the case of cattle (and poultry) that this probably occurs to any extent. In other species such as horses, sheep, goats, dogs and cats, sporadic cases only occur in which an extraneous source of infection human or bovine can often be traced. In pigs, tuberculosis seems to be due usually to the ingestion of milk from tuberculous cows. In some cases, such as in herds fed with hotel swill, we can easily suppose a human origin as well. Whether the disease is liable to be spread and perpetuated in a herd by infection from animal to animal seems to be as yet undetermined.

As to the transmissibility of tuberculosis from man to cattle under natural conditions, this event, from the evidence which we have now obtained of the comparatively feeble susceptibility of cattle towards human tubercular sputa, must be regarded as unlikely. It can hardly be said that this evidence amounts to proof of the absolute impossibility of such transmission under a combination of favoring circumstances, but, evidently, such an occurrence must be so rare as hardly to constitute an obstructive factor in any means adopted for the eradication of cattle tuberculosis. So far as contagion is concerned that derived from other diseased cattle would appear to be practically all that need be guarded against, provided that other sanitary measures are not neglected. I may here state my conviction, strengthened by what these latest experiments disclose, that no means which stop at a mere attempt at avoidance or destruction of contagion will ever result in a permanent suppression of tuberculosis in cattle or greatly reduce its prevalence in mankind. That contagion in the form of tubercle bacilli is an essential factor in tubercular disease no bacteriologist will attempt to dispute, but the influence of predisposing causes should not on that account be underestimated. Of these I attach the most importance to defective ventilation—breathing of vitiated air. In cattle we find the proof of this in the rarity, practically the absence, of tuberculosis among the herds of unstabled cattle in the southwest of our own country, and in other countries where similar conditions prevail. Further than this, a spontaneous eradication of the disease from an infected herd may occur when the pernicious influence of stabling is removed. Although possessing little opportunity for making observations of this kind, I have myself knowledge of one instance in which this occurred, and can readily believe that it may be of frequent occurrence.

It is not my purpose here to enter on the question as to how this great agricultural problem—the limitation or suppression of bovine tuberculosis—should be approached, but whether by radical or by temporizing methods, it is certain that these should be supplemented by some measures calculated to counteract the evils of unsanitary cow stables. In relation to human tuberculosis also it may not be out of place to state that even at this day there is ample room for missionaries to preach the gospel of pure air.

A discussion of the transmissibility of tuberculosis from cattle to mankind, really the most important question in connection with bovine tuberculosis, is beyond the scope of this article, but it is not out of place here to point out in what way the facts now obtained may tend to modify our views on this subject. The generally assumed transmissibility of the disease to man by the use of milk from diseased cows, rests mainly on a speculative basis, and its importance is variously estimated by pathologists. It cannot be said that the facts here presented remove the question in any degree out of the domain of speculation. They really furnish more food for theorizing and may either diminish or increase our suspicion of dairy products according to the process of reasoning employed. It may be argued for instance, since bovine tubercle bacilli have been shown to be equally as virulent as those of human origin for all animals tested, and more virulent for some, the presumption is that they are more virulent for mankind also. Contrariwise, it may be said that human tubercle bacilli being shown to be less adapted for growth in cattle than the bacilli of bovine origin, there is reason for believing that the converse may also be true. The latter view supposes a permanent racial distinction between the human and bovine bacillus, while, according to the former, the difference in pathogenic power must be attributed to a relatively attenuating effect on the bacillus by passage through the human organism. If the bovine bacillus be regarded as merely a more highly virulent modification of the human variety this should be shown by the greater gravity of the lesions produced by comparative inoculation experiments on all species of susceptible animals. If, however, there is a selective feature shown by such inoculations, the excess of virulence of the bovine variety being manifested only towards certain species of animals, some support would be gained for the theory of a distinction of races other than that founded on a mere difference in degree of pathogenic activity. It is from this point of view that I have endeavored to approach the subject in collecting such evidence as was obtainable as to the effects of human and bovine tubercle on animals other than cattle, and in the few experiments I have as yet been able to complete. The evidence so far available is hardly sufficient to risk an opinion upon, but on the whole seems to lend some support to this latter view.

It is, of course, not by inoculation experiments alone that this problem can be satisfactorily investigated, but by these in conjunction with a comparative study of the biological features of artificial cultures. It cannot be said that any very striking difference in cultural characters have so far been discovered but some slight distinguishing features have been pointed out by Smith in the article already quoted. This author, the first who has made a comparative study of human and bovine tuberculosis by the use of artificial cultures, arrives, as we have seen, at the same conclusion as some of the earlier investigators in their experiments with the natural disease products, and finds in his researches reason for the belief that the danger of human infection from cattle has been generally exaggerated. This seems to fairly represent the status of pathological opinion at the present time.

AN EXPERIMENT IN GRAZING A CORN AND COWPEA FIELD WITH STEERS.

BY R. L. BENNETT.

The experiment reported herewith was made to secure information of the value and profit of grazing off a corn and cowpea field (after the corn was pulled), and feeding cotton seed to the animals, as their appetites required. It is the common practice in this State to leave corn fodder and corn stalks in the fields for cattle to graze. The grazing, however, is not always done in a systematic manner, and frequently it is done without feeding cotton seed. There is no doubt that much profit can be realized by properly grazing off such fields and by feeding cotton seed to the animals at the same time, a profit in the animals and in the improvement of the soil. A still greater profit, however, would be realized from both sources if farmers would sow cowpeas in the corn.

In the spring of 1898 five acres of uniform sandy soil was planted in Hickory King corn, and cultivated in the ordinary way. June 10, Black cowpeas were dropped 18 inches apart in the corn. The corn yielded 25½ bushels per acre, hardly an average crop. The cowpeas were favored with a good season, and made more than an average growth of vines, but less than an average crop of peas, and perhaps 50 per cent was destroyed by excessive rains in September and October. The ears of corn were pulled as soon as sufficiently dry, leaving the shucks or husks on the stalks. None of the peas were picked. On October

6 five average steers, three years and over, and in good thrifty condition, were put to grazing on one-third of the 5-acre field. After the vines, stalks, and fodder were grazed as close as the steers would graze them, another one-third was similarly grazed, and the same thing repeated with the last third of the field. While the steers were grazing the field cotton seed was kept accessible, and was eaten as the appetites of the animals dictated.

During the first thirty days of the grazing, when the pea vines were yet green, and peas were to be had, the steers ate very little cotton seed. If the steers had been allowed the run of the whole field, and not confined to small areas, they would have ruined a considerable part of the vines and stalks by tramping over them.

The five steers required sixty-four days to consume or graze off the foods on the 5 acres. Their gains during the sixty-four days and the cotton seed consumed are as follows:

No. Steers.	Weight at beginning of grazing.	Weight at end of grazing 64 days.	Gain, pounds.
1	602	722	120
2	976	1,142	166
3	800	914	114
4	716	828	112
5	764	896	132
	3,858	4,502	644

Average gain per steer in sixty-four days.....128 4-5 pounds.
Average gain per day for sixty-four days...........2 pounds.

Cotton seed consumed by five steers in sixty-four days ....1,251 pounds.
Cotton seed consumed per steer in sixty-four days 250 pounds.

COST PER STEER OF FEEDING SIXTY-FOUR DAYS.

Cotton seed, 250 pounds, at $6 per ton	$ .75
Cowpea seed, 1½ bushels per acre	.75
Dropping seed in corn at third cultivation, per acre	.20
Cost of labor to feed seed, once daily, for sixty-four days	.30
Cost to feed one steer sixty-four days to gain 128 4-5 pounds	$2.00
Cost of gain per pound	1.6 cents

NOTES AND SUGGESTIONS ON THE GRAZING.

In estimating the cost of the grazing the cotton seed and cowpeas are charged to the feeding, but it is reasonable to suppose they will, as manure scattered over the soil, increase the yield of the succeeding crop more than their cost. The advantages of feeding cotton seed to the steers instead of corn are cheapness as a food and greater value as a fertilizer. It was estimated that the steers grazed the three lots of the field about as follows: On the first lot all the pea vines, husks, fodder, and about one-fourth of the stalks were eaten. On the second and third lots, frost having fallen October 22, the steers ate about two-thirds of the pea vines, all the husks and fodder, but scarcely any of the stalks. Results of the grazing of this field indicate that the corn should be gathered and the animals turned to grazing as early as possible before frost. With early planted corn, grazing could begin in most seasons about September 15, which would be three weeks earlier than the grazing was begun in this trial. The advantages of early grazing are freshness of food and more time for grazing the crops before frost. If this field could have been grazed three weeks earlier the grazing could doubtless have continued that much longer, as more of the crops would have been eaten that were refused after frost. When cattle are to be fattened for beef, this period of grazing puts them in most excellent condition to be immediately followed by a period of thirty to sixty days of feeding on cotton meal and hulls. In planting cowpeas in corn for grazing a running variety is better than a bunch variety.

The improvement of the soil from the grazing of this field will be reported later, when the crops that are growing on it are harvested.

YIELD OF SPANISH PEANUTS PLANTED DIFFERENT DISTANCES.

This variety of peanut is better adapted than any other for growing hay and nuts for stock. Its vine grows upright, and is easily cultivated and cut for hay, and its nuts grow clustered around the base of the vine and are easily harvested with a plow or by pigs. When the vine and nuts are harvested together and fed to stock the food is both grain and hay combined. Two lots of five plots each were planted in Spanish peanuts, in rows 3 feet apart in one lot, and 2 feet apart in the other. The nuts were planted different distances in the rows, but alike for the two plots.

ROWS TWO FEET APART.

		Bushels.
4	inches between each plant or hill, yield per acre......	172
6	inches between each plant or hill, yield per acre......	100
8	inches between each plant or hill, yield per acre......	136
12	inches between each plant or hill, yield per acre......	164
18	inches between each plant or hill, yield per acre......	132
48		704

9.6 inches average between plants or hills, average yield 140 bushels.

ROWS THREE FEET APART.

		Bushels.
4	inches between each plant or hill, yield per acre.......	124
6	inches between each plant or hill, yield per acre......	108
8	inches between each plant or hill, yield per acre......	106
12	inches between each plant or hill, yield per acre......	115
18	inches between each plant or hill, yield per acre......	95
48		548

9.6 inches average between plants or hills, average yield 109 bushels.

The variation in yield of individual plots indicates that the average 8 or 9 inches between plants in the row would be the best distance on the station soil, and that 2 feet between rows is better than 3 feet. The 2-foot rows are a little more difficult to cultivate than 3-foot rows, so a medium distance, 2½ feet, between rows, might be adopted.

PLANTING UNSHELLED PEANUTS.

The expense of shelling peanuts for planting large areas is quite considerable, so with a view of reducing that expense, trials were made of planting unshelled nuts after having kept them for different periods of time in sacks in the ground below the freezing point. The object of this treatment before planting was to soften the hulls so that the young plants could more easily escape when the nuts were planted.

On January 1 a small quantity of nuts were put in a sack and immersed in water for twelve hours to thoroughly wet the hulls, then the sack was put in the earth below freezing. On February 1, March 1, and April 1, sacks of nuts were similarly treated. These four sacks of nuts remained in the earth until April 23, when they were taken up and planted without being shelled. On the same date plantings were made of shelled nuts and of nuts dry and unshelled, and also of nuts with pods broken into two parts. The Spanish peanut grows two peas in a pod and, therefore, can be easily broken between the peas. The per cent of a perfect stand secured from planting peanuts treated in the different ways described is exhibited in the subjoined table.

PER CENT OF A PERFECT STAND.

Nuts shelled at planting, dry nuts	94.8
Nuts broken into two parts, dry nuts	95.1
Nuts dry and unshelled	75.1
Nuts unshelled, put in earth April 1	92.5
Nuts unshelled, put in earth March 1	55.5
Nuts unshelled, put in earth February 1	37.7
Nuts unshelled, put in earth January 1	None

From this trial it appears that nuts planted in broken pods make as good stand as shelled nuts, and that those put in the earth April 1, twenty-three days before planting, made practically as good stand. The dry nuts shelled at planting came to a perfect stand about seven days before those two plantings. From this test I think that nuts after having been thoroughly wet and then kept moist for three to five days before planting will produce a good stand; that a longer time than three weeks is a disadvantage. This trial has not been repeated, and the results must be accepted accordingly. It indicates clearly, however, that some, if not all, the expense of shelling peanuts by hand for planting can be saved.

RELATIVE EFFECTS OF COTTON MEAL, WHOLE AND CRUSHED SEED ON THE YIELD OF CORN, COTTON AND POTATOES.

The question is frequently asked which of these forms of plant food is best for certain crops. In answering it by field experiment, the soil, season, and crop, would have to be taken into account, and for that reason this test on the station soil is mainly of local value. It is reported, however, to show certain facts that very likely would occur in any trial and on any soil. The chief among the facts referred to is that cotton meal would be expected to make a larger yield than whole or crushed seed would make when applied to crops that mature in a short time. The reason for this difference is that the plant food in cotton meal is in a more readily available condition for quick and rapid growing crops. On long growing crops like cotton and corn, the plant food in whole and crushed seed becomes available about as fast as needed by those crops.

In this trial the same quantity of cotton meal was used alone as was applied in the form of whole and crushed seed. The whole seed were slightly fermented to destroy the germ. The fertilizers were applied to the soil in furrows, then covered and the seed of the crops planted.

CORN.

		Yield per acre, bushels.
1.	Cotton meal, 375 pounds	34.7
2.	Crushed seed, 1,000 pounds	34.2
3.	Whole seed, 1,000 pounds	34.5
4.	No fertilizer applied	26.0

COTTON.

		Yield Seed Cotton per acre, pounds.
1.	Cotton meal, 375 pounds	1,350½
2.	Crushed cotton seed, 1,000 pounds	1,402½
3.	Whole cotton seed, 1,000 pounds	1,481½
4.	Nothing	1,268¾

POTATOES, IRISH.

		Yield per acre, bushels.	
1.	Cotton meal, 375 ℔.	51 marketable	16 unmarketable
2.	Crushed seed, 1,000 ℔.	35 marketable	35 unmarketable
3.	Whole seed, 1,000 ℔.	23 marketable	35 unmarketable
4.	Nothing		25 unmarketable

For some unknown reason the yields in this test are very small, but they show that cotton meal is better for potatoes than whole seed or crushed seed. Its superiority is most probably due to the reason given above. And the superiority in this test of cotton seed and crushed seed for cotton is similarly explained. The meal when applied to cotton was doubtless largely consumed by the cotton plants before they began much fruiting. A partial explanation of the small yields of these crops where cotton seed, meal and crushed seed were applied as compared with plots without any applications is the need of the soil for vegetable matter, rather than for plant food.

RELATIVE EFFECTS ON COTTON AND CORN OF CERTAIN LEGUMINOUS CROPS TURNED UNDER ENTIRE AND THEIR STUBBLE ONLY TURNED UNDER.

Cowpeas, Soja beans, and Velvet beans were grown in rows on adjoining plots of uniform fertility, and at proper stages of growth half of the Cowpea and Soja bean plots were cut and removed for hay. In November all of each plot was turned under, and in the spring they were bedded, and cotton planted May 10. During the entire growing season no difference could be seen in the cotton on the different plots.

The plots yielded as follows:

COTTON.

Plots.		Yield Seed Cotton per acre, pounds.
1.	Cowpeas, vines turned under	1,335
2.	Soja beans, vines turned under	1,488
3.	Velvet beans, vines turned under	1,550
4.	Cowpea stubble, vines cut for hay	1,292
5.	Soja bean stubble, vines cut for hay	1,262

Soja bean vine and stubble plots exceeded the Cowpea vine and stubble plots in yield of cotton, but the Cowpea hay is superior to Soja bean hay, because there is less waste to the Cowpea. The Cowpea stubble plot exceeded the yield of the Soja bean stubble plot. The Velvet bean plot exceeded the yield of the Cowpea and Soja bean plots, but a test of its stubble alone was not made, because its vines are so long that mowing and handling for hay is very difficult. Another disadvantage of the Velvet bean is that it does not mature enough seed this far north. In the extreme southern part of the State it very probably will mature seed every season.

CORN.

A similar trial to the above was made with corn, except that Velvet bean was omitted.

Plots.	Yield Corn per acre, bushels.
1. Cowpeas, vines turned under	37
2. Soja beans, vines turned under	42
3. Cowpea stubble, vines cut for hay	33
4. Soja bean stubble, vines cut for hay	33
5. Cotton grown on plot previous year	26

Cowpeas and Soja beans had the same relative effect on corn that they had on cotton. The value of the hay cut from the two stubble plots was worth more than the increase of corn and cotton on the plots where the vines were turned under for manure.

ALLEN HYBRID COTTON.

Seed of this variety of cotton was received from the Department of Agriculture, and was planted to compare its merits with Eldorado cotton, which is an excellent variety and is grown to some extent in the State.

YIELD PER ACRE OF SEED COTTON IN POUNDS.

Eldorado	1,421¼
Allen Hybrid	1,209⅜

LENGTH OF FIBER AS GINNED ON SAW GIN.

Eldorado	1⅛ inches
Allen Hybrid	1½ inches

PER CENT OF LINT TO SEED COTTON.

Eldorado	29
Allen Hybrid	28

The two varieties grow very much alike, and have the so-called "sugar loaf" form of stalk. The Eldorado grows a little larger and has larger and less pointed bolls. The fiber of the Allen Hybrid is more silky and finer to the touch than Eldorado, but the latter is more productive and better for general cultivation. There is little if any advantage in growing a long staple cotton, unless it could be ginned on a long staple or roller gin. There is a decided advantage, however, in growing a well bred and productive variety of cotton, whether it be a long or short staple, and it is equally important that the farmer select his planting seed in the field and not from the common pile at the public gins.

R. L. BENNETT.

THE COMPARATIVE YIELD OF CORN FROM SEED OF THE SAME VARIETY GROWN IN DIFFERENT LATITUDES.

A great deal has been written and said concerning increasing the production of Indian corn, and suggestions made as to how such an end might be brought about. The one phase of this subject that has been discussed more than any other for the past three or four years has been regarding the source of seed for planting. A few have recommended that the seed should be grown further south than the locality in which they are to be planted, while many claim that they should come from further north; and equally as many, if not more, advocate growing the seed in practically the same locality in which they are to be planted. The columns of the *Texas Farm and Ranch* have contained a number of articles on the subject from a number of parties — some claiming that Texas grown seed produced more corn than Northern grown, others claiming Northern seed gave the better yield, and each writer seemed to base his conclusions upon either experience or observation, but the comparisons were usually based upon the results from one Northern grown and one Southern grown sample, and these were not always of the same varieties.

In January and February, of 1898, samples of seed corn were collected from eighteen States, and from twenty in 1899. Samples of each variety were procured from as many localities as possible, and in a majority of cases the seed had been grown for several generations in the same locality. Fifty-eight seedsmen were communicated with, many of whom gave the exact locality where the seed were grown, and some of them the exact or approximate number of consecutive generations the varieties had been grown in the one place. Equal areas of each variety were planted and each plot thinned to the same number of stalks. No fertilizer was used and each plot was given the same cultivation and on the same day.

The corns were divided into three lots, the division being controlled by the latitude in which the seed were grown. The samples grown north of the thirty-eighth parallel being designated "Northern grown," south of the thirty-fifth parallel, "Southern grown," and those grown between the thirty-eighth and thirty-fifth parallels "middle grown;" the latter corresponding approximately to the latitude of Fayetteville, where the experiments were conducted.

In 1898 samples were procured from nine Northern States, from seven middle, and two Southern. In 1899 from ten Northern, seven middle and three Southern. The plots were gathered when well ripened and stored until cured, when they were husked and weighed in the ear and the yields per acre calculated. Every precaution was taken to treat each plot alike from the preparation of the soil to the final weighing of the product. The rows were 3½ feet wide and the hills 18 inches apart. The stand was almost perfect. When the stalks were 4 to 6 inches tall, they were thinned until they were the same number on each plot.

In many cases the difference in the yield from samples of the same variety was very great, and in some instances the yield from one sample was more than twice that of another, though they were grown in approximately the same latitude. One of the most striking is to be found with the Golden Dent, grown in 1898. Three samples of this variety, procured of three seedsmen, who represented the seed to have been grown north of the thirty-eighth parallel of latitude, produced respectively 15.9, 48.8, and 15.9 bushels per acre. The plots were within a few feet of each other, and no difference in the fertility of the soil was noticeable, and the seed were apparently true to name.

The seed with which the plots producing 15.9 bushels were planted, were grown in Wisconsin and Ohio; the other in Pennsylvania. It is difficult to account for so great a difference in yield.

In the case of Leaming, samples grown in Pennsylvania, Ohio, and Kansas, produced respectively, 20.1 bushels, 20.3 bushels, and 44.3 bushels per acre, and all three lots of seed were true to name as far as could be detected.

In 1899 seven samples of Leaming, grown north of the thirty-eighth parallel, did not vary in yield more than 3 bushels per acre, and in 1898 seven samples of Early Canada varied in yield only 3.1 bushels per acre.

This tends to prove that it is unsafe to draw conclusions from a few tests, and that corn is extremely susceptible to change of soil and climate. If unfavorable conditions and environments so materially diminish the yield it should naturally follow that favorable conditions and environments would increase it, and particularly should this be true if the proper care was exercised in saving and preserving the seed. This is rarely done by the farmer.

Seven varieties, the seed of which were secured more uniformly from the three sections, are given separately in tabulated form. An examination of the tables is interesting, and in some instances the difference between the yields of the *same varieties* from *different sources,* is *greater* than the individual and average difference between *different* varieties from *various* sources.

Champion White Pearl is grown to some extent in Arkansas and Texas. Many bushels of seed grown north of the thirty-eighth parallel have been sold in Texas for planting. The average yields of the two years' test gives more than 25 per cent increase in favor of the Southern and middle sections. The greatest yield from any one of the eleven samples was from Texas grown seed, while the next largest was from Tennessee seed.

TABLE I.

Champion White Pearl.	Seed Grown North of 38th Parallel of Latitude.		Seed Grown Between 38th and 35th Parallel of Latitude.		Seed Grown South of 35th Parallel of Latitude.	
	1898 Bushels per Acre	1899 Bushels per Acre	1898 Bushels per Acre	1899 Bushels per Acre	1898 Bushels per Acre	1899 Bushels Per Acre
Yields from the various samples.............	30.5 17.2	21.5	32.0 36.1	30.0	19.0 33.0 42.4	34 0 23.5
Average of each year.	23.75	21.5	34.0	30.0	31.46	28.75
Average of each section............................	22.62 bu.		32.0 bu.		30.10 bu.	

Seed of Early Mastodon, grown south of the thirty-eighth parallel, were difficult to procure. Two samples were disregarded, as they were evidently not true to name. The average yields from the three sections are practically the same, the highest, 49 bushels per acre, being from Northern grown seed, as was the lowest yield of 18.5 bushels.

The plot producing only 18.5 bushels was alongside one producing 30 bushels. No local cause could be detected that would cause any difference. The question seems to be: Did one sample inherit a reduced producing capacity, or the other increased producing capacity?

TABLE II.

Early Mastodon.	Seed Grown North of 38th Parallel of Latitude.		Seed Grown Between 38th and 35th Parallel of Latitude.		Seed Grown South of 35th Parallel of Latitude.	
	1898 Bushels per Acre	1899 Bushels per Acre	1898 Bushels per Acre	1899 Bushels per Acre	1898 Bushels per Acre	1899 Bushels per Acre
Yields from the various samples	49.00	29.5	31.5	35.5	32.9	34.0
	39.20	34.0	32.5			
	39.9	28.0				
	35.1	23.0				
		21.0				
		18.5				
		30.0				
Average of each year.	40.8	26.28	32.0	35.5	32.9	34.0
Average of each section	33.54 bu.		33.75 bu.		33.45 bu.	

Golden Beauty shows wide differences between yields from individual samples from various localities, and in the average of yields from seed from the three sections. The lowest yield, 21 bushels, was from Northern grown seed, and the highest, 68.9 bushels, was from the middle section. The averages of the yield from the Southern and middle grown seed were more than 25 per cent greater than the average of the Northern grown.

TABLE III.

Golden Beauty.	Seed Grown North of 38th Parallel of Latitude.		Seed Grown Between 38th and 35th Parallel of Latitude.		Seed Grown South of 35th Parallel of Latitude.	
	1898 Bushels per Acre	1899 Bushels per Acre	1898 Bushels per Acre	1899 Bushels per Acre	1898 Bushels per Acre	1899 Bushels per Acre
Yields from the various samples	37.0 30.8 41.6 22.4 52.4	28.0 21.0 27.5 31.0 33.0 29.0 32.0	53.2 43.8 68.9	35.0 37.5	64.2	39.0 38.5
Average of each year.	36.84	28.78	55.3	36.25	62.2	38.75
Average of each section..................................	32.81 bu.		45.775 bu.		50.475 bu.	

Golden Dent shows some apparent inconsistencies in the yield from individual samples planted in 1898. Seed grown in New Jersey gave 48.8 bushels per acre, while Wisconsin seed gave only 15.9 bushels per acre. Virginia seed gave 41.8 bushels, and Missouri seed 17.3 bushels per acre. The average of the samples from the three sections, however, come very close together, varying less than 4 bushels per acre.

TABLE IV.

Golden Dent.	Seed Grown North of 38th Parallel of Latitude.		Seed Grown Between 38th and 35th Parallel of Latitude.		Seed Grown South of 35th Parallel of Latitude.	
	1898 Bushels per Acre	1899 Bushels per Acre	1898 Bushels per Acre	1899 Bushels per Acre	1898 Bushels per Acre	1899 Bushels per Acre
Yields from the various samples..............	19.5	19.0	17.3	23.5	33.2	24.5
	21.0	21.0	41.8	28.5	17.0	14.0
	15.9	20.5	21.5	18.0		35.0
	48.8	26.5				
	15.9	18.0				
		20.0				
		21.5				
		12.0				
		17.0				
		14.0				
Average of each year.	24.04	19.0	26.86	23.33	25.1	25.5
Average of each section...............................	21.52 bu.		25.09 bu.		25.30 bu.	

Hickory King in 1898 also shows widely divergent yields. Texas grown seed yielded 49.7 bushels per acre; Arkansas grown seed, 41.0 bushels, and Wisconsin grown seed only 18.5 bushels per acre.

In 1899 there was a comparatively narrow difference between the yields of seed grown in three sections. The average for the two years gives the middle section an advantage of about 10 per cent.

TABLE V.

Hickory King.	Seed Grown North of 38th Parallel of Latitude.		Seed Grown Between 38th and 35th Parallel of Latitude.		Seed Grown South of 35th Parallel of Latitude.	
	1898 Bushels per Acre	1899 Bushels per Acre	1898 Bushels per Acre.	1899 Bushels per Acre	1898 Bushels per Acre	1899 Bushels per Acre
Yields from the various samples	39.5 18.5 21.0 21.0 20.0	29.0 27.0 25.0 28.0 18.5 21.0 25.0	37.0 41.0 39.0	21.0 28.5 23.5 25.5	49.7 20.7	24.0 22.0
Average of each year	25.0	24.71	39.0	24.62	35.2	23.0
Average of each section	24.855 bu.		31.81 bu.		29.10 bu.	

Leaming varied very little, comparatively, in the crop of 1899, but greatly the year before. Kansas grown seed produced 44.3 bushels per acre, while Pennsylvania and Ohio grown seed produced 21.1 bushels and 20.3 bushels per acre respectively. Another sample from Pennsylvania produced 36.7 bushels, and one from New Jersey 25.1 bushels per acre.

TABLE VI.

Leaming.	Seed Grown North of 38th Parallel of Latitude.		Seed Grown Between 38th and 35th Parallel of Latitude.		Seed Grown South of 35th Parallel of Latitude.	
	1898 Bushels per Acre	1899 Bushels per Acre	1898 Bushels per Acre	1899 Bushels per Acre	1898 Bushels per Acre	1899 Bushels per Acre
Yields from the various samples..............	25.1	14.0	29.4	17.0	21.4	13.0
	20.3	17.0	26.5	21.0		
	36.4	18.0	44.3			
	26.7	17.0				
	25.3	17.0				
	22.7	17.0				
	20.1	15.0				
Average of each year	25.52	16.44	33.4	19.0	21.4	13.0
Average of each section..............................	20.98 bu.		26.2 bu.		17.2 bu.	

White Dent, while more of a *class* than a *variety* of corn, is grown very probably more than all other varieties in the South, and under the name of "White Dent." The highest yield was made from seed grown on the station farm at Fayetteville for four consecutive years. The original seed were procured of the Oklahoma Experiment Station. This sample produced 59.8 bushels per acre. A sample from the South Carolina Experiment Station produced 57.4 bushels, while one from Ohio gave only 19 bushels per acre.

TABLE VII.

White Dent.	Seed Grown North of 38th Parallel of Latitude.		Seed Grown Between 38th and 35th Parallel of Latitude.		Seed Grown South of 35th Parallel of Latitude.	
	1898 Bushels per Acre	1899 Bushels per Acre	1898 Bushels per Acre	1899 Bushels per Acre	1898 Bushels per Acre	1899 Bushels per Acre
Yields from the various samples	23 8	21.0	36.4	33.5	34.1	38.5
	23.0	20.5	34.0	38.5	41.6	24.0
	19.0	26.5	29.0	26.5	57.4	16.2
	32.6	19.0	41.0	40.5	50.6	17.0
			59.8	30.0	40.0	28.0
			26.5	25.5		
			33.6	22.0		
			30.4	28.5		
			42.0	30.0		
			42.0	19.0		
Average of each year	26.6	21.75	37.39	32.0	44.75	24.8
Average of each section	24.175 bu.		34.695 bu.		34.775 bu.	

The large area required for these tests renders a comparison of the yield of one *variety* with another unfair, since it was impracticable to secure an area of sufficient size that possessed the necessary uniformity of fertility. The samples of each variety were, however, grown on soils of uniform producing capacity. The Golden Beauty and Hickory King varieties were on more fertile soil than the others, while White Dent and Leaming were on less fertile. The extreme difference in the producing capacity of the whole area in the tests was less than 6 bushels per acre in 1898, and less than 5 in 1899, as indicated by check plots of the Oklahoma White Dent. Two plots of this variety were planted from home grown seed adjacent to each of the other varieties. It might be mentioned incidentally that the Oklahoma home grown Dent planted thus as a check exceeded the yields of all these divers varieties, with the exception of one plot of Golden Beauty.

That a comparison might be made of the yields of these seven varieties from seed grown in different latitudes the average for each section is given in the following table:

TABLE VIII.

Names of Varieties.	Seed Grown North of 38th Parallel of Latitude.	Seed Grown Between 38th and 35th Parallel of Latitude.	Seed Grown South of 35th Parallel of Latitude.
	Averages for two years.	Averages for two years.	Averages for two years.
Leaming	20.98	26.20	17.20
Golden Beauty	32.81	45.775	50.475
Hickory King	24.855	31.81	29.10
Golden Dent	21.52	25.09	25.30
Champion White Pearl	22.62	32.00	30.10
Early Mastodon	33.54	33.75	33.45
White Dent	24.175	34.695	34.775
Average	25.785	32.76	31.485

Thus it is seen that seventy-five samples of seven varieties of corn from seed grown north of thirty-eighth parallel of latitude yielded an average of 25.78 bushels per acre; forty-nine samples of the same varieties from seed grown between the thirty-eighth and thirty-fifth parallel of latitude yielded an average of 32.76 bushels per acre, and thirty-one samples of the same varieties from seed grown south of the thirty-fifth parallel yielded an average of 31.48 bushels per acre. The middle section averaged 6.98 bushels per acre more than the Northern, and 1.28 bushels more than the Southern section. The Southern section produced 5.7 bushels more than the Northern.

In the two years' tests 223 plots of corn were grown from samples grown in the three sections. These include several flint varieties, seven of Early Canada, and eight of the Pride of the North. These two varieties did practically nothing, and tend to lower the averages of the Northern grown corns more than any other varieties, except the flints.

TABLE IX.

108	Samples of eighteen varieties of corn from seed grown north of the 38th parallel of latitude yielded at the rate of	23.79 bu. per acre.
74	Samples of twenty varieties of corn from seed grown between the 38th and 35th parallels of latitude yielded at the rate of	32.49 bu. per acre.
41	Samples of fourteen varieties of corn from seed grown south of the 35th parallel of latitude yielded at the rate of	29.50 bu. per acre.
223	Samples of corn averaged	28.26 bu. per acre.

These tests, considered as a whole, have a decided tendency to prove that the corn plant has an elastic nature, and is greatly affected by a change of environment. A variety from Texas required two weeks more time for maturity than the same variety from Ohio.

In Bulletin No. 57 of the Office of Experiment Stations, Dr. E. L. Sturtevant, in his description of Leaming, says:

"Season as 117 days in Connecticut, 115-123 days in Indiana, 135 days in Illinois, 110-128 days in Iowa, 110-124 days in Kansas, 146 days in North Carolina."

Thus the extremes of time required for maturity were 110 days in Kansas and Iowa, and 146 in North Carolina, a difference of thirty-six days. This great difference very probably was augmented by differences in rainfall and temperature, but the tests reported here frequently showed a difference of a week or ten days between the time required for the maturity of two samples of the same variety procured from different sources, though but 3½ feet of space separated the plots. The difference in the season was not, however, so great nor so irregular as the difference in the yields of the same plots. As a rule the highest yields were from the late or medium late Dent or gourdseed varieties, and from seed grown in the same, or very near the same latitude of Fayetteville. Several plots planted in seed of five varieties collected within a few miles of Fayetteville, produced more in every instance than the total averages of the various samples collected from any one of the three sections, notwithstanding that four of these varieties were selected at random from corn grown on farms near Fayetteville, and sold in the local market.

The results of the two years' experiments indicate that seed corn grown in the same or nearly the same latitude as that in which it is to be planted, will give the best results, and that seed grown in the neighborhood where they are to be planted are preferable to those grown further North or further South.

TABLE SHOWING CONDITION OF THE WEATHER FROM MARCH 1 TO SEPTEMBER 30, 1898.

Day of Month	MARCH			APRIL			MAY			JUNE			JULY			AUGUST			SEPTEMBER		
	Temp'ture		Rain in	Temp'ture		Rain in	Temp'ture		Rain in	Temp'ture		Rain in	Temp'ture		Rain in	Temp'ture		Rain in	Temp'ture		Rain in
	Max.	Min.	Ins.	Max.	Min.	Ins.	Max.	Min.	Ins.	Max.	Min.	Ins.	Max.	Min.	Ins.	Max.	Min.	Ins.	Max.	Min.	Ins.
1	68	37	......	62	36	.07	72	56	1.75	86	65	......	89	65	T	83	58	......	90	69	......
2	40	28	......	60	36	......	78	57	......	89	62	......	89	66	......	83	62	1.10	89	69	......
3	47	24	......	62	44	T	69	58	1.00	88	68	.05	91	65	......	80	63	.60	92	70	......
4	52	20	......	68	37	.10	70	57	2.95	80	64	.27	86	65	.05	87	55	......	91	72	......
5	56	32	......	47	29	......	72	51	1.12	78	62	.32	86	62	.57	90	60	......	91	74	......
6	64	34	......	50	25	......	62	51	.01	86	64	.22	89	66	......	89	65	......	82	59	.08
7	70	30	......	58	31	......	70	40	......	83	64	.28	92	70	......	87	67	.87	72	49	......
8	70	42	......	63	42	......	79	41	......	86	63	.02	94	71	T	82	68	1.05	83	44	......
9	70	52	T	73	49	T	80	45	......	84	65		88	66	......	84	64	......	81	46	......
10	60	54	.16	58	52	.40	79	56	......	83	63	.20	82	58	......	88	60	......	73	55	.05
11	60	46	1.40	70	42	......	83	50	......	83	64	.34	83	54	......	83	63	......	70	59	.75
12	48	38	2.10	67	48	T	86	56	T	83	61	.85	83	50	......	85	59	......	70	59	2.65
13	63	32	......	61	39	.38	86	56	......	85	61	.05	84	50	......	84	59	......	79	59	......
14	71	44	......	67	35	......	84	56	......	87	64	.26	82	61	......	88	64	......	84	62	.01
15	71	46	.38	75	36	......	76	58	......	87	62	.37	89	55	......	88	64	......	83	59	.10
16	76	52	.45	82	41	......	85	65	......	81	66	.85	89	59	.13	89	65	......	89	70	......
17	70	47	2.50	80	60	......	83	59	......	84	68	......	86	65	.07	91	67	......	85	62	.07
18	79	56	.03	73	55	1.10	80	68	......	88	61	......	89	66	......	90	67	.72	91	63	......
19	74	57	.61	66	49	......	78	60	1.20	88	66	.11	90	69	......	94	67	......	83	62	......
20	60	54	1.70	74	44	......	74	59	1.72	88	65	......	89	64	1.78	95	67	......	83	63	T
21	68	52	1.80	76	52	.03	77	59	.67	91	66	.15	87	65	.52	98	68	......	75	61	.80
22	68	27	.29	71	55	.70	85	52	......	91	65	......	96	68	......	93	69	......	85	60	.01
23	32	23	.70*	69	54	......	86	52	......	91	66	......	92	67	......	93	69	......	78	65	......
24	51	19	......	70	48	.20	89	53	......	89	68	......	85	67	.14	91	71	......	90	68	......
25	60	32	......	72	42	......	88	59	......	88	73	......	90	66	......	88	69	.09	92	66	......
26	68	49	.18	68	38	.01	86	59	......	86	72	......	92	64	......	90	64	......	94	64	......
27	68	30	2.55	72	40	......	85	64	......	87	62	1.85	93	66	......	90	62	......	92	64	......
28	50	24	......	73	53	.91	88	63	......	88	64	......	94	68	......	92	61	......	90	64	......
29	56	32	......	76	44	......	90	71	......	89	65	......	92	71	......	95	64	......	83	62	.01
30	51	33	.22	76	63	.03	85	55	......	89	67	......	91	60	1.85	92	65	......	77	64	T
31	59	30	......	......	......	......	86	61	......	......	......	......	93	60	2.00	86.	68	.05	......	......	......
	Total	..	15.07			3.93			10.42			5.69			7.11			4.48			4.53

T Trace or less than .01 of an inch. * 1 inch snow.

TABLE SHOWING CONDITION OF THE WEATHER FROM MARCH 1 TO SEPTEMBER 30, 1899.*

Day of Month	MARCH			APRIL			MAY			JUNE			JULY			AUGUST			SEPTEMBER		
	Temp'ture		Rain in Ins.	Temp'ture		Rain in Ins.	Temp'ture		Rain in Ins.	Temp'ture		Rain in Ins.	Temp'ture		Rain in Ins.	Temp'ture		Rain in Ins.	Temp'ture		Rain in Ins.
	Max.	Min.		Max.	Min.		Max.	Min.		Max.	Min.		Max.	Min.		Max.	Min.		Max.	Min.	
1	67	33	......	51	22	......	82	65	.09	83	59	.26	89	59	......	91	67	......	90	63	......
2	78	38	......	62	37	......	79	62		82	64	......	89	67	......	93	67	......	92	65	......
3	72	58	......	62	35	......	69	56	.49	86	69	......	87	73	.02	95	68	......	96	63	......
4	51	29	.06	42	28	......	74	53	......	86	71	......	78	74	1.07	91	71	......	98	63	......
5	45	19	.06	47	35	.37	66	55	......	87	64	......	89	61	.55	91	73	......	99	71	......
6	30	10	......	42	34	......	77	56	3.10	86	70	......	90	70	......	92	72	......	98	73	......
7	44	31	......	50	34	......	80	57	2.00	78	66	1.56	88	78	1.47	94	74	......	97	75	......
8	65	28	......	49	30	T	79	62	......	83	65	.50	87	63	......	96	72	......	90	70	......
9	74	52	......	60	28	......	88	57	......	79	63	......	81	61	......	98	74	......	87	65	......
10	68	57	......	76	45	......	76	64	.08	78	60	.02	86	57	......	96	69	......	85	67	T
11	64	31	.07	77	62	......	74	61	T	83	63	......	88	58	......	96	71	......	86	59	......
12	55	27	......	81	60	......	74	60	T	86	65	......	88	63	......	98	71	......	92	47	......
13	66	39	......	77	61	......	82	58	......	85	70	T	90	61	......	95	70	......	86	60	......
14	70	45	......	70	51	T	83	61	......	85	72	.09	89	64	......	78	65	.92	87	48	......
15	60	31	......	69	51	......	87	66	......	74	65	.48	90	67	......	87	62	......	90	52	......
16	65	41	......	71	42	......	81	69	......	78	62	......	87	68	......	89	64	......	91	62	......
17	61	47	.75	72	47	......	78	68	......	76	53	......	80	67	.07	89	65	......	80	62	.78
18	61	28	.06	73	50	.74	79	63	......	83	51	......	85	63	.01	90	65	......	70	58	......
19	59	23	......	83	52	......	82	62	......	85	61	......	84	64	......	94	65	......	74	44	......
20	67	32	......	76	46	......	82	65	......	87	66	......	81	64	1.58	99	76	......	72	42	......
21	66	58	......	48	45	.97	86	67	T	87	66	......	81	71	.22	100	71	......	78	41	......
22	56	38	......	59	46	.69	86	59	T	88	66	......	87	67	1.62	101	73	......	82	52	......
23	51	28	.04	59	44	T	71	56	1.38	85	60	......	88	64	......	97	68	......	86	62	......
24	63	36	......	73	43	......	78	49	......	88	60	......	88	66	......	97	65	......	90	64	......
25	74	59	......	84	46	......	82	54	......	89	71	T	88	65	......	88	65	1.05	72	47	......
26	59	34	......	77	63	......	83	65	......	88	69	......	91	64	......	95	69	......	70	37	......
27	42	28	.02	76	64	T	83	62	......	88	66	......	91	65	......	93	69	......	72	42	......
28	36	22	......	87	58	......	81	68	T	88	67	.68	90	66	......	94	63	......	62	53	......
29	59	29	......	86	68	......	86	61	......	89	59	......	89	73	......	93	59	......	68	32	......
30	67	36	......	78	66	T	82	65	.37	85	60	......	88	67	.81	89	59	......	75	35	......
31	46	25	......	...	...	......	83	68	.05	...	...	......	90	69	......	91	60	......	...	...	......
Total			1.06			2.77			7.56			3.59			7.40			1.97			.78

* Table prepared by J. F. Moore, Assistant Chemist and Weather Observer.

On March 4 trace of snow fell, and on 5, 18, 28 snow to the depth of ½ inch fell each day. Ice ¼ inch thick on September 29. T Trace.

SECOND REPORT ON ARKANSAS SEEDLING APPLES.

BY JOHN T. STINSON.

A preliminary report on Arkansas Seedling Apples was published in January, 1898, as Bulletin No. 49 of this station. Since publishing that report several of the varieties described in it, as well as new ones, have been more closely studied. It is probable that some of these varieties may prove valuable in other sections, but they should be thoroughly tested as to their hardiness and productiveness before they are planted largely in commercial orchards.

Trees of some of the most promising varieties have been sent to other experiment stations, and to horticulturists interested in them in other sections of the country. It is hoped that much information regarding them will soon be obtainable. We have already received some reports regarding their hardiness in sections north, where fruit trees were badly damaged last winter by severe cold, but the information is not extensive enough to draw conclusions from; however, it indicates that some of them are likely to prove hardy as far north as Central Iowa. Most of these varieties have been in fruiting for years in the sections where they originated, and large orchards of some of them have been bearing for several years.

A special effort has been made to straighten out the nomenclature of certain new varieties, and it is pleasing to know that most of the leading nurserymen are adopting the names given here to the varieties. Most of these names are those by which the varieties have been known locally for years. The committee of the American Pomological Society for revision of the catalogue of fruits has adopted the names given the apples here.

ARKANSAW (MAMMOTH BLACK TWIG).

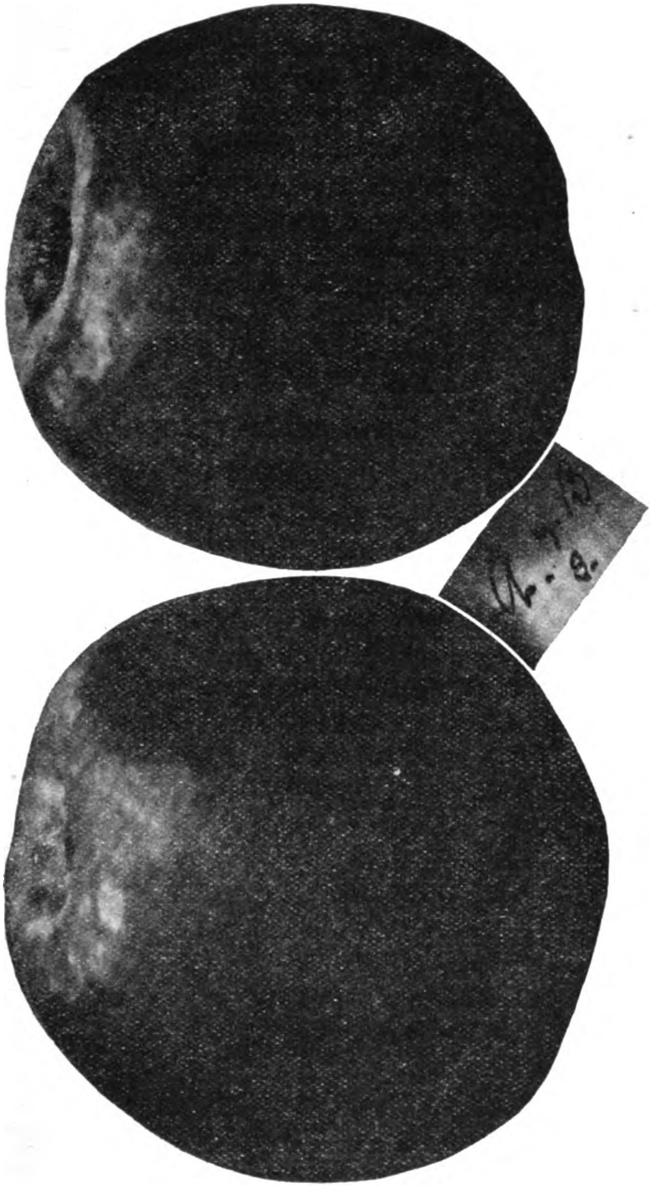
The history of this variety was given in Bulletin No. 49. The name Arkansaw for the variety is being adopted by nurserymen. It is difficult to change from a name in common use as is the name Mammoth Black Twig, however, Arkansaw is probably a better name, as it conforms to the rules of the American Pomological Society, and should be generally adopted. The apple is rather a shy bearer here. It has often been said of it that old trees bear well, and that it is only a poor bearer while young, but usually the crops indicate that it bears light on all trees. The orginal tree had a fair crop of apples on it this year. It is probably safe to advise against planting this variety on a large scale in commercial orchards here; however, the variety may do well elsewhere.

ARKANSAS BEAUTY.

Size, medium to large; form, roundish, slightly inclined to conical; stem very long and rather slender; cavity, small, smooth; basin, small; core, open with a peculiar marking of a white growth or downy substance in seed cavities; color, skin yellow, striped with two shades of red, rather dull in color, giving it a brownish red appearance; flesh, yellow, fine grained; subacid, and very good; juicy. It is grown to some extent in a few sections of the State; is probably grown more in Johnson County than elsewhere. It has not proven valuable.

ARKANSAS BELLE.

Mr. D. Branchcomb, of Rhea, Ark., tells me that he is confident that this is a seedling. The old tree is standing in his seedling apple orchard. It resembles Gano, and may be identical with it. For the present, at least until the variety fruits in other localities and more is known of it, it will not pay to plant it when trees of Gano can be easily obtained. The apple was exhibited at the recent meetings of Missouri and Illinois Horticultural Societies, and had many admirers, but all concluded that it resembled Gano closely. The trees in the nursery here resemble Gano.



D. Etris.

C. Arkansas Belle.

ARKANSAS BLACK.

It has proven to be a poor bearer in both Washington and Benton counties, where it is grown in all localities. It originated in Benton County, but is there pronounced worthless as a commercial apple. The crop is usually damaged more or less by apple scab, as it is more susceptible to this disease than most varieties. It is said to succeed in some sections of the southern part of the State, but as these are not apple growing sections, other varieties have probably not been tested sufficiently to determine the relative value of it. It is not recommended for general planting.

BEACH (LADY PIPPIN, RICHARDSON RED, APPLE OF COMMERCE).

Since the publication of the preliminary report on Arkansas Seedling Apples in 1898, we have become convinced that the two apples mentioned as Beach (Lady Pippin) and Richardson Red (Apple of Commerce) are one variety. At that time we had not been able to trace them to the same source, but since then we have been able to do this. We found that the scions from which the trees known as Richardson Red were grown came from the same source as did those of Lady Pippin. About thirty years ago they were furnished by Oliver Young, a local nurseryman, to Mr. Highfill for grafting, and he named the apple Lady Pippin. The Richardson Red trees also came from Mr. Young. This variety is productive and the apple is a good keeper when perfect specimens are obtained. The quality of the fruit is fair only, and as there are so many better apples, the planting of this variety is not advised. The apples this year were small, and many of them were ill shaped and faulty.

BRIGHTWATER.

* "Large, round, conical, with a greenish yellow surface, somewhat mottled with russet, and heavily splashed, striped, and shaded with dull red; dots, minute, yellow and brown;

---

*Report of the Pomologist, U. S. Dept. Agr., 1892.

skin, thick; flesh, greenish yellow; fine grained; juicy; core, large, conical, closed, clasping; calyx tube very long; seed, few, large, pointed, brown; flavor, subacid; quality, good; season, winter."

It is fruiting in a few orchards near Avoca, and is said to be a promising apple by those fruiting it. It has not been extensively planted. The apple is fairly attractive, and is a good keeper.

CARTER.

Size, medium to large; roundish; cavity not regular, medium, abrupt, russeted; stem, short, stout; basin, small, corrugated, slope medium; eye, closed; surface, smooth, yellow ground covered with a bright red, very highly colored; dots rather indistinct; flesh, yellowish, fine; mild, subacid; very good; a fine apple; season, winter.

COFFELT.

Medium size, some large; roundish, flattened; cavity, regular, smooth, medium depth, gradual slope; basin, medium, rather abrupt slope, corrugated; eye, open; surface, smooth; color, yellow ground splashed and streaked with red, rather dull color; small dots on surface; flesh, greenish yellow, rich, tender; flavor, mild, subacid; very good; good keeper; winter apple. It originated with Mr. Wyatt Coffelt, in Benton County, and has been propagated for a number of years. It is highly spoken of by some as a desirable variety to plant instead of Limbertwig.

COLLINS (COLLINS RED, CHAMPION RED, COSS'S CHAMPION, CHAMPION).

It gave a good crop this year on young trees and the growers were well pleased with it, but on older trees the apples were small, owing to overproduction, and the results were not so satisfactory. The fruit is well colored and smooth. It is a good keeper, and the apples are usually nearly all marketable. This is a promising apple and a safe variety for planting in this section. The original tree is still bearing good crops of fruit.

CRAWFORD (CRAWFORD PIPPIN).

Size, medium to large; form, roundish and somewhat flattened; cavity, narrow and medium, abrupt, russeted; stem, short and stout; basin, medium to shallow, medium slope, smooth; calyx, open; surface, smooth; color, deep yellow with blush, and splashed with red on one side; dots, medium size and numerous; flesh, yellowish, medium texture, moderately juicy, rich; flavor, very good; season, early winter. It has not proven a good bearer, and is not highly spoken of by apple growers in the vicinity of Boonsboro, where it originated. It has not been extensively propagated.

ELKHORN.

* "The Elkhorn is an apple which originated on the old battleground of Pea Ridge, Ark., near Elkhorn Tavern, and was given the name from that fact. It was brought to notice by G. F. Kennan, of Brightwater, Ark., in the fall of 1886, and promises well.

Size, large to very large, often 4 inches in diameter; shape, flat, not conical, regular; surface, yellowish, well covered with rather dull mixed red and darker stripes; handsome, but not brilliant; dots, numerous, very large, light gray, on distinct and lighter bases; basin, large, closed, or nearly so; cavity, wide, deep, heavily russeted; stem, very short, slender; core, large, clasping, open; seeds, large, flat, dark colored; flesh, yellowish, firm, a little coarse, juicy; quality, very good; season, December to spring in Arkansas."

It has not been grown to any large extent and is not considered valuable here.

ETRIS.

This variety is claimed to be a seedling, and it may be one, but it resembles Gano so closely that there seems to be no reason for keeping the varieties distinct. Since publishing Bulletin No. 49 we have taken occasion to compare the varieties a num-

---

*Report of the Pomologist, U. S. Dept. Agr., 1886.

ber of times, and are led to believe that they are practically identical. It is grown extensively in Benton County.

FLORENCE.

Size, medium; form, roundish, oblong or nearly oblong; cavity, narrow, acute, very slightly russeted; calyx closed, small; basin, narrow, abrupt and medium; core, large, open; color, yellow ground covered and splashed and somewhat striped with red; surface covered with small white dots; flesh, yellowish, rich, mild, subacid, tender, very fine grained; season, with Jonathan. It is quite extensively grown by Mr. W. E. Buchanan, Bentonville, Ark., who has a large orchard of it in bearing.

GILL'S BEAUTY.

Size, large; form, round, rather flat, would be called a flat apple; vertical section rather flat; cross section round; cavity, regular, narrow, depth medium, slope rather abrupt; basin, shallow, slightly corrugated; eye, nearly closed; surface, smooth; color, greenish yellow ground, nearly covered with red; a fine appearing apple; dots, small; skin, tough; flesh, nearly white, coarse, juicy; mild, subacid; core, rather large; quality, good. A good bearer of fine large apples, but they do not escape the bitter rot, and for this reason it is not considered advisable to plant it here.

GIVENS.

This apple is growing in favor. This year a good crop was produced on Givens trees, and the apples were nearly all marketable. It is a splendid keeper and a good seller. The fruit ripens up late after other varieties have been gathered. This variety is also known as the Arkansas Baptist apple. It was given this name by Mr. Highfill, but as there is an apple known as Baptist, the name Givens was given it in honor of Mr. John Givens, on whose farm the apple originated. It is worthy of more general planting.

GOLD.

Size, medium; long, rather pointed; conical; calyx, partly open; basin, shallow; cavity, medium to deep, large, slope gradual, russeted; surface covered with russet dots; color, rich, golden yellow, from which it derives its name; flesh, yellow, fine grained, tender, juicy; very good; core, small; subacid, sprightly; season, early winter.

HOWARD SWEET.

This variety is said to have originated on the farm of Mr. Howard, near Cincinnati, Ark. The tree was bought from the Holt nursery about the close of the war, and this tree is said to be still standing on the Howard place. It is productive and the apple is large. It is claimed by some that it is identical with Lady Sweet, while others say that it is not, and as there are no trees of Lady Sweet in this section we have been unable to make a comparison of the fruit from the same locality. It has been extensively planted in the neighborhood of Cincinnati, Ark. It is a large, highly colored apple and probably will prove a good market variety. This may or may not be Lady Sweet, but in either case it will pay those in search of a sweet apple to grow it.

LOGAN.

Size, medium; form, oblate, roundish; stem, rather short to medium; cavity, deep, lipped usually; basin, medium, sloping sides, ribbed; color, red on yellow ground, or perhaps better, bright crimson; skin, smooth, oily; flesh, solid, yellowish, tender; quality, good; subacid, nearly acid. Promises to be a good keeper and a fine market apple. It is a beautiful apple, and attracts much attention at fruit shows.

OLIVER (OLIVER'S RED, SENATOR).

The crops from trees of this variety were rather disappointing the past season, as the apples were quite small on account of overproduction. They were well colored, however, and kept well for a fall apple. There are some complaints regarding the unhealthiness of the trees of this variety, but they are not general enough to attract attention; but still it may be best to thoroughly test the variety before planting it largely, even in this section.

OZARK.

*"Size, large, 3 to 4 inches; shape, round, regular, but sometimes unequal; surface, very smooth, light yellow, covered with suffused bright carmine; dots, small, light, on raised bases; basin, deep, wide, abrupt, regular; eye, small, closed, or nearly so; cavity, wide and deep, russeted but little; stem, short, slender; core, regular, closed; seeds, large, long, dark; flesh, white, tender; flavor, subacid; quality, good; season, November to December in northwestern Arkansas."

This apple has not been propagated extensively, but is in bearing in several orchards in the northern part of Benton County, and is spoken highly of by some.

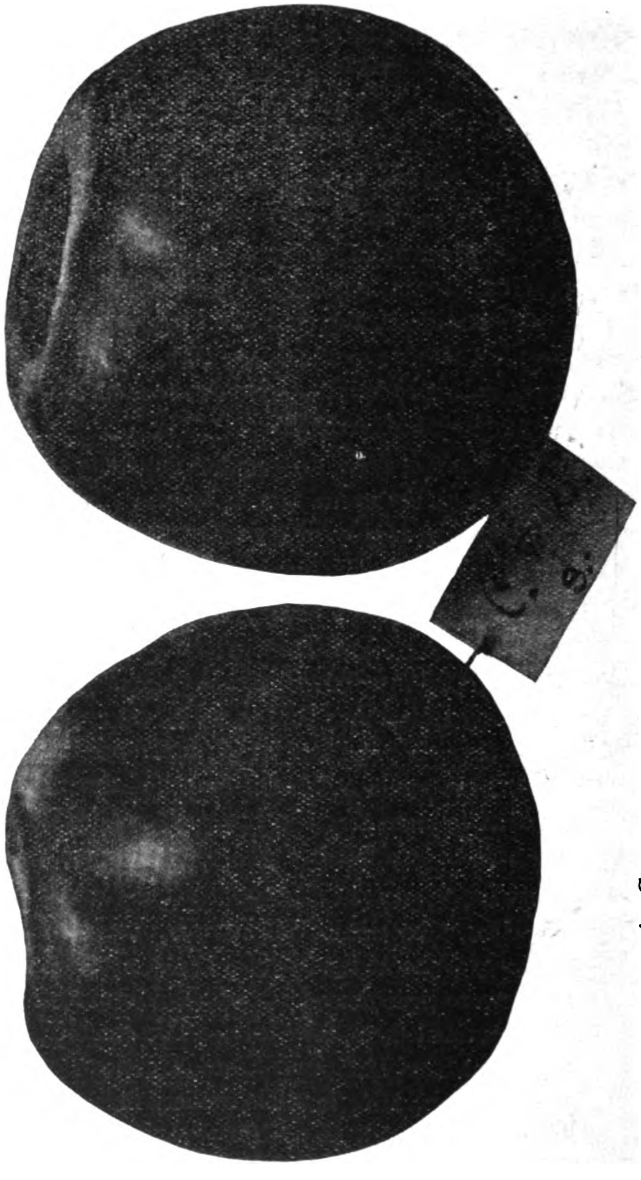
REAGAN (BLACK BEN DAVIS).

Our study of the trees in the nursery and the fruit of this variety leads us to believe that this variety and Gano are identical. It has been stated that this is a distinct seedling. This may be so, but there is practically no difference between the varieties. We have made a careful study of the matter here, and are prepared to state that the two varieties are identical as far as we are able to determine.

I compared specimens of the apple called Black Ben Davis, grown by an Illinois horticulturist from scions from Arkansas, with specimens of Gano at the Illinois State meeting at Springfield, and they were pronounced identical by a number of those present who examined them carefully. The committee on new seedling apples at the Missouri State Horticultural Society meeting at Princeton, Mo., last December, reported that they were unable to distinguish any difference between Black Ben Davis, Etris, and Gano.

---

*Report of the Pomologist, U. S. Dept. Agr., 1887.



A. Gano.

B. Black Ben Davis.

SHANNON.

* "There has been so much said lately about this variety that a description is here given, although it is not new. For many years there has been some confusion of this variety with one known as Ohio Pippin. But after carefully studying the specimens that I have received under both names, and examining the trees, I think they are distinct. The specimen from which I made the accompanying illustration and written description was grown by Mr. Garrett Williams, of Hindsville, Ark., in 1886. It was a fair average specimen in all respects, and came from near where the variety originated in that State.

Size, large to very large, 3 to 4 inches; shape, flat, conical, regular, or appearing a little elliptical when viewed from the end; surface, very smooth, yellow, occasionally faintly blushed, with a dull overcast of whitish blotches and streaks; dots, small, indistinct, white or light gray; basin, shallow, waved a little; eye, large to medium, open; cavity, shallow, regular, russeted; stem, very short, often fleshy; core, wide, open, clasping the calyx tube; seeds, short, plump, dark; flesh, yellow, rather coarse, juicy; flavor, mild, subacid, not rich; quality, good only; season, October to February in Arkansas."

The Shannon is said to have originated near Boonsboro, this county. It may be identical with Ohio Pippin, but the name Shannon is so much better known than the other that it seems advisable to adopt it. It is the most popular apple grown here for certain markets South, and it is not excelled in flavor. It is a poor bearer, but the high prices secured for the crop is an incentive for planting it to some extent. It is a fall apple in this section.

SILOAM.

* "Size, medium, 2½ to 3 inches; shape, flat, regular, almost like Rawle's Genet; surface, smooth, yellow ground, about half covered with rather dull red stripes and splashes; dots, numer-

---

*Report of Pomologist in U. S. Report, 1886.

*Report of the Pomologist, U. S. Dept. Agr., 1886.

ous, small, light gray; basin, shallow, regular; eye, small, closed; cavity, shallow, russeted; stem, very short; core, wide, nearly closed, clasping the calyx tube; seeds, small, plump, dark; flesh, yellow, fine grained, juicy; flavor, subacid, rich; quality, almost best; season, December to spring in Arkansas."

It is said to have originated near Siloam Springs. It has not been propagated to any extent, and is of less value than many other varieties little grown.

SPRINGDALE.

Size, medium; shape, roundish and flattened; cross section round; vertical section, rather flattened; cavity, regular, somewhat russeted, medium depth, sloping gradual; stem, medium to stout, medium length; basin rather shallow, somewhat corrugated, gradual slope; calyx, open; surface, covered with small rather indistinct russet dots and small russet patches; color, greenish yellow, ground, splashed with dull red, with heavier indistinct stripes of red; flesh, slightly yellow with greenish tinge, very solid, only fairly tender; subacid; good; said to be a good bearer; good keeper; season, winter.

It has not been propagated to any great extent, and is not considered promising.

STEVENSON PIPPIN.

* "An Arkansas apple, which originated with the Cherokee Indians in what is now Pope County, and was first brought to notice by a Mr. Dwight, of the Dwight mission, as it was known for a long time. James G. Stevenson, of Crawford County, Ark., obtained trees of the variety, propagated and disseminated them, and they are highly esteemed where known. Tree, a vigorous, upright grower, somewhat spreading with age and bearing; not an early bearer, but produces heavy and light crops alternately."

This variety is too well known to need description. It is grown in most sections of northwest Arkansas, and is considered desirable for family orchards.

---

*Downing's Fruits and Fruit Trees of America.